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The Walker Universal Tool and Cutter Grinder—I.

We present herewith illustrations of an improved universal tool and cutter grinder, built by the Norton Emery Wheel Co., Worcester, Mass. The machine is known as the "Walker" grinder, and is a development of similar, but less complete, machines which have been previously illustrated in our columns.

On this page the machine is shown complete and equipped for any kind of grinding, *i. e.*, for milling cutters of any form, or for cylindrical or conical, external or internal grinding.

Most of the parts which regularly go with this machine are listed separately if desired, so that a user can, by making his own selection, obtain a machine adapted to his requirements without the expense of things he has no use for, while at the same time any of the remaining parts can be obtained at any time and they will fit, being made strictly interchangeable.

This machine preserves the interchangeable iron wheel center or collet system, which has been a feature of all previous machines made by this company, and the number of emery wheels accompanying the machine has been increased, twenty-four emery wheels accompanying each complete machine. Fig. 2 shows a longitudinal section through one of the iron centers or collets. The wheel is held firmly by the screw collar (98), and the whole is then screwed upon the spindle (1) by hand, and removed in like manner. The central screw (7) working in nut (132) forces the collet upon the tapered end of the spindle. It is intended that each regular wheel shall be permanently mounted on a collet to facilitate quick changes of wheels, and to insure their truth in each case, the facility of making changes of wheels and having them always true, enabling the operator to always use the wheel best adapted to the work in hand.

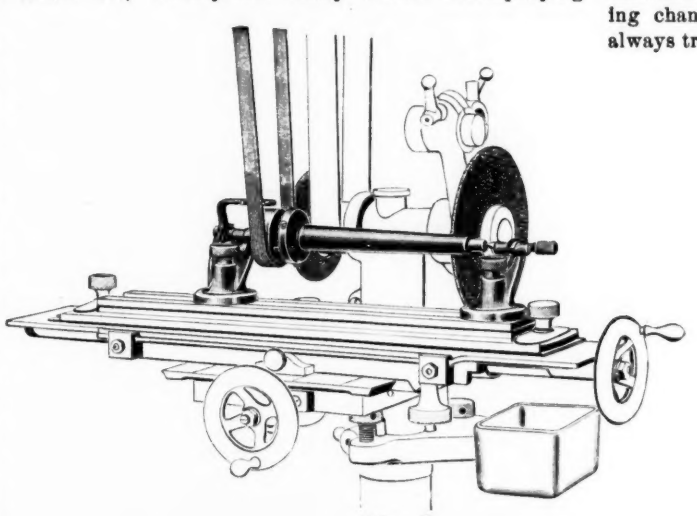


Fig. 3.

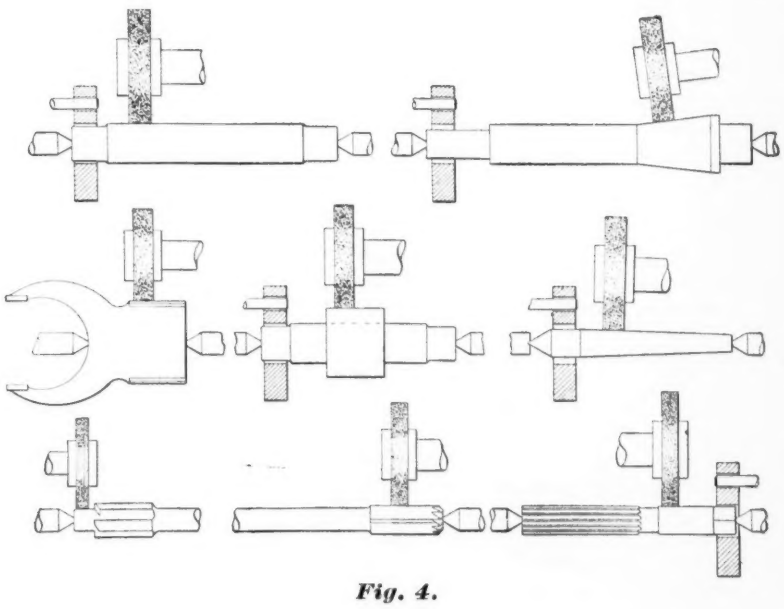


Fig. 4.

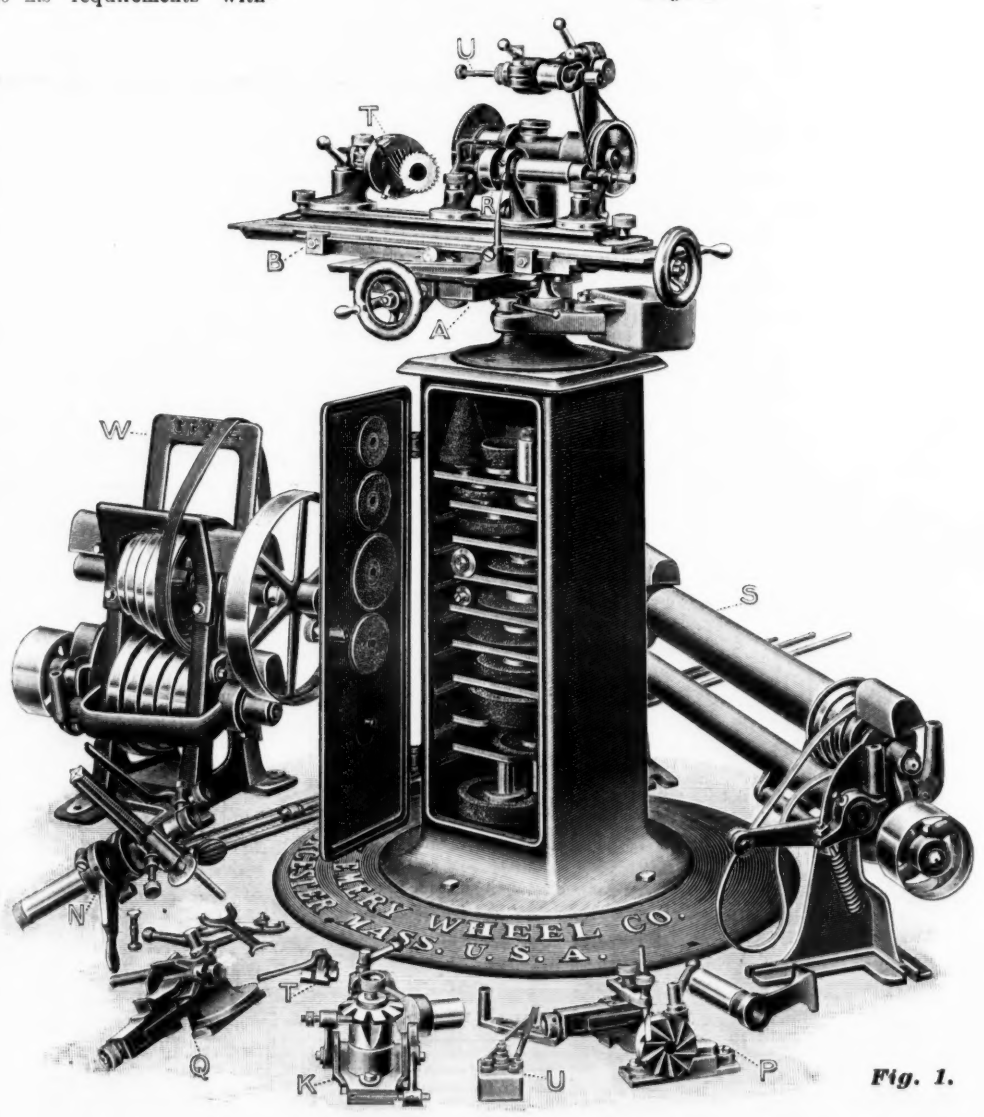


Fig. 1.

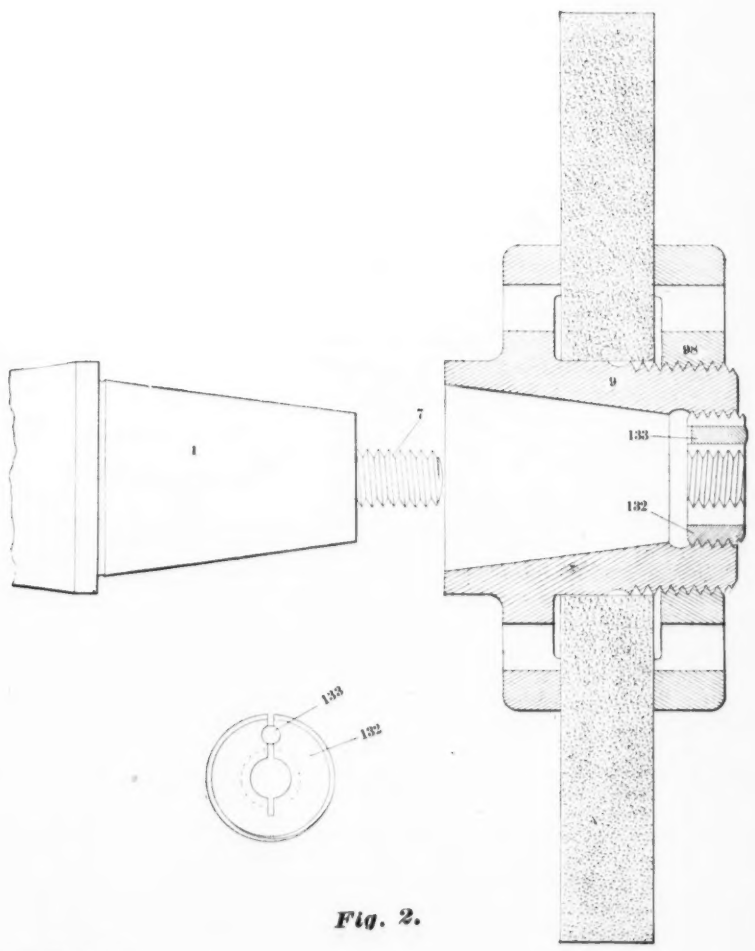


Fig. 2.

THE WALKER UNIVERSAL TOOL AND CUTTER GRINDER.

As shown by the engraving, the machine is mounted on a substantial iron column which forms a wheel cabinet, and the large separate base plate has been retained to give steadiness on shaky floors. The desirability of a wide range of speed for various-sized emery wheels being strongly advocated by this company, the five speed countershaft (previously illustrated in these columns) is furnished, and is shown at the left of the machine, while at the right is the drum from which the work is driven. This also is friction driven, has four speeds, and is adjustable vertically to give any desired tension to the belt going down to the driving plate.

Referring to Fig. 1, *U* is the internal grinding spindle and connected mechanism,

R is the driving face-plate, belt guide and dead center, *T* is the 4-inch universal chuck, spindle, etc., *N* is the regrooving attachment for grooving and sharpening taps, reamers, etc., by grinding in the grooves, *Q* is the universal cutter holder which holds all cutters, straight or taper shanks, without the use of sockets or collets, *K* is holder for grinding gear cutters, and *P* the end, or butt mill holder. All these parts will be explained more fully as the methods of using them are shown.

At Fig. 3 the machine is shown as arranged for grinding tapers upon dead centers, and Fig. 4 indicates the method of doing a variety of work, cylindrical and taper, upon dead centers.

Fig. 5 shows the universal chuck and spindle in position for facing a disk or cutter. The head-stock in which this spindle is mounted is graduated in degrees at the base, and it can thus be set at any required angle for grinding bevels.

At Fig. 6 several different and typical jobs of chuck grinding are indicated, some of these being done by the use of the internal grinding spindle which, with other special features of the machine, we shall more fully illustrate and describe next week.

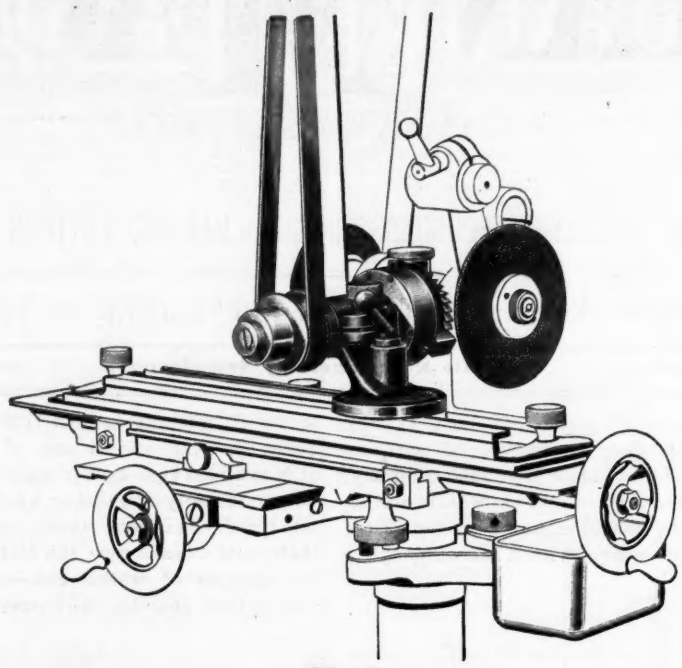


Fig. 5.

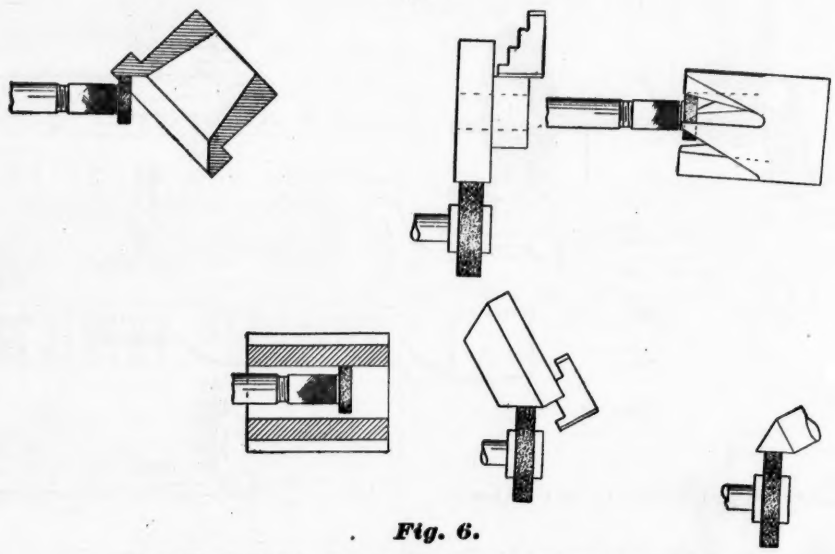


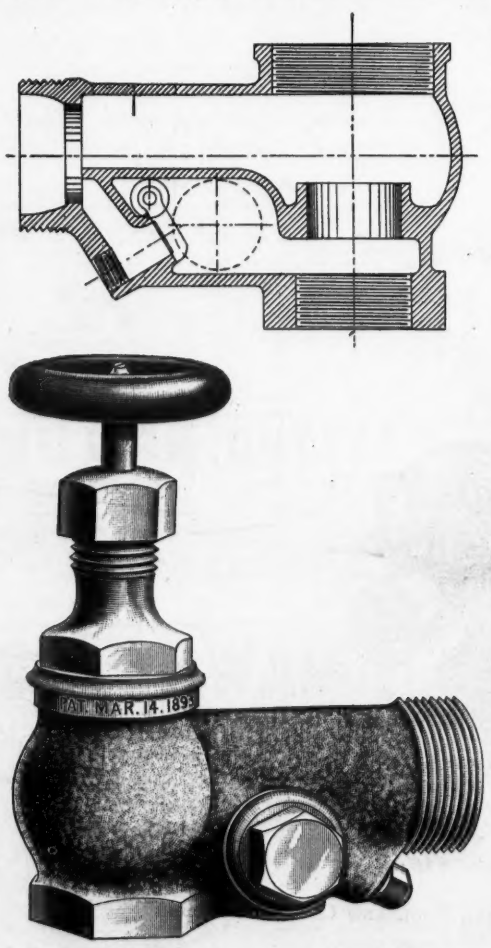
Fig. 6.

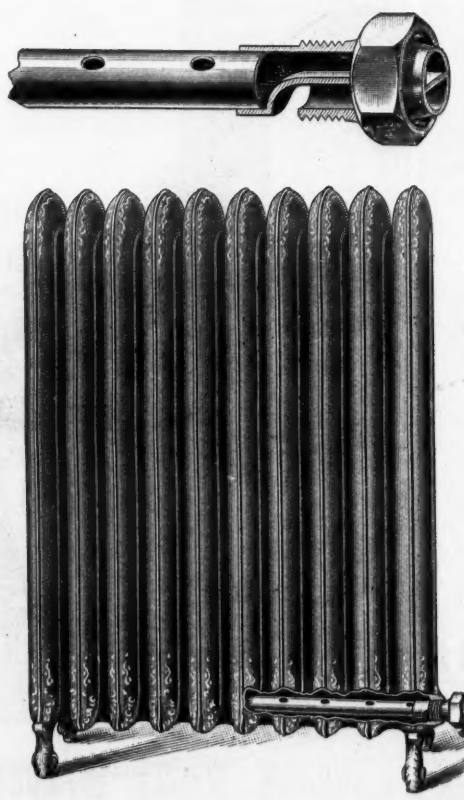
THE WALKER UNIVERSAL TOOL AND CUTTER GRINDER.

Improved Radiator Valve.

In our issue of April 19th we illustrated and described an improved "compound" radiator valve made by James H. Hutchinson, 117 West 115th street, New York City. It will be remembered that this valve provided for both the inlet of steam and the escape of condensation (by means of the check shown in the sectional view herewith) and that Mr. Hutchinson also arranged for a steam pipe entering each end of the radiator, both pipes being controlled by the same valve. The object of this last-mentioned feature was to get a more thorough distribution of steam and thus make a larger proportion of the heating surface actually hot than is the case when the steam enters at one end only.

The present improvement consists in putting steam into one end of the radiator only, but providing an interior pipe as shown, connected with the valve and having perforations corresponding to the manifolds of the radiator, so that each one of these must get practically the same amount of steam. This device has been tried and found to work perfectly; all parts of the radiators being fully heated.





IMPROVED RADIATOR VALVE.

The Resurrection of an Old Friend.

Another scientific magazine has appeared. It is called *The New Science Review*, and, according to the title-page, it will be published quarterly. In the first number we note with interest an article by Mrs. Bloomfield Moore, entitled, "A Newton of the Mind," rather a high-sounding title, considering that the Newton referred to is none other than the celebrated John Ernst Worrell Keely, the unspeakable, imperishable, perennial Keely, of motor fame. It appears that he is at last on the high road to success. All the obstacles that have hitherto balked him and made his life one dreary stretch of misery and ache have dissolved away; he has finally laid bare the heart of nature, so that he can stick a pin through it and preserve it for future reference.

He comes from Table Mountain, and his name is
Truthful James;
He is not up to small deceit, nor any sinful games;
But he'll tell in simple language what he knows
about the how
Of the going of the motor that has never gone till
now.

Let us therefore sit reverently at his feet and drink in the honeyed words of wisdom as they drop from his lips. "Physicists," he says, "have been working in the wrong direction to lead them to associate with nature's sympathetic evolutions. It is not necessary to advance further into the unexplored region of these sympathetic flows than the ninths, to become convinced that the one I denominate the dominant is the leader toward which the remaining thirds of the triune combination (of triple sympathetic streams) co-ordinate, whether it be the cerebellic, gravital, or magnetic. When we reach the luminiferous track on the ninths, in the triple subdivision, we have proof that the infinite stream, from that unexplored region where all sympathetic streams emanate, is triune in its character, having the dominant as the sympathetic leader, to which the remainder of the celestial thirds are subservient." And again, "The nearer the approach to the neutral centers, when the dissociation takes place, the greater is the latent force evolved. In molecular dissociation the instrument is set on the thirds, meeting with a rotating resistance of 5,000 pounds per square inch, without any interference with the inter-molecular position. . . . . To reach the atomic centers the instrument is set on the ninths dominant, the sixths harmonic, and the thirds enharmonic, having the transmittive chord *B* associated with each. At this setting the corpuscular percussion exceeds 25,000 pounds per square inch. The subservience to the co-ordinate sympathy is shown in the result by a pressure exceeding 15,000 pounds, reaching, in this subdivision, almost as near the neutrals as instruments can carry us. The atomic and inter-atomic settings constitute the introductory conditions governing the nodal outreach as toward the etheric. . . . . The region of the inaudible is reached—the introductory etheric and the first features of the invisible latent force existing in corpuscular embrace have been handled."

Bravo, Keely! Spencer doubtless had you in mind when he cried, "Witness the pomposity of sesquipedalian verbiage!" The trouble with you, Keely, is that your language is mere words—it doesn't mean a single, solitary, most microscopic thing. We don't know whether you are crazy, or what is the matter with you; but we honestly think it is time for you to call in your family doctor.—*The Locomotive.*

Train Motion and Resistance.

BY R. E HORTON.

The resistances to which the motion of a train is subject are due to four causes, namely,

1. Flange and journal friction.
2. Atmospheric resistance.
3. The transition of curves.
4. The ascent of grades.

Were it not for these resistances, the locomotive exerting a uniform tractive force would give the train a uniformly accelerated motion, the velocity increasing indefinitely with the time.

It is my purpose to determine how the resistance due to the first two causes given above modifies the train's motion, that is, to determine the motion of a rail train on a straight level track under known laws of frictional and atmospheric resistance, the effect of grades and curves being for the present neglected, as they may be considered as special cases under the general theory.

For convenience we will adopt the following notation:

W = gross weight of the train in pounds.

v = the train's speed or velocity in feet per second.

t = the time of motion in seconds.

R = the total resistance in pounds on a straight level track at any velocity.

V = the maximum velocity which the train can acquire.

P = the tractive force of the engine in pounds.

g = the acceleration of gravity = 32.16 feet per second.

The frictional resistance is independent of the velocity, but varies as the weight of the train, hence we may write: Frictional resistance = $a\ W$, where a is a constant whose value may be taken as $\frac{1}{280} = 0.0035714$, which is equivalent to a frictional resistance of 8 pounds per ton of 2,240 pounds.

For the best American practice a is generally somewhat smaller than given above. Prof. De Volson Wood gives it as $6\frac{1}{2}$ pounds per gross ton, though the above value is more generally adopted. In any case, it equals the force necessary to just move one ton of the weight of the train on a straight level track.

The frictional resistance is also in a measure dependent on the size of the driving and truck wheels, decreasing as the diameters of these are increased.

The resistance of the atmosphere is difficult to express by means of a simple formula, since it varies with the velocity in a complicated manner, and its laws can only be deduced by higher mathematics. It may, however, be shown that for ordinary velocities, the atmospheric resistance varies

nearly as the square of the velocity, and as the surface exposed, which latter is nearly proportional to the weight of the train. Hence we may write: Atmospheric resistance $= C\,W\,v^2$.

For ordinary conditions we may take the constant

$$C = \tfrac{1}{823000} = 0.000001214.$$

For a long train the atmospheric resistance is less than for a short one, and less for high speeds than for low, since for very high speeds the train carries a sort of atmosphere of its own, and the friction of the atmosphere on this moving mass of air being less than on the rough joints and corners of the train, would tend to decrease the resistance.

The total resistance is the sum of the frictional and atmospheric resistances. Hence

$$R = (a + C\,v^2)\,W, \qquad (1)$$

or, numerically,

$$R = \left(\frac{1}{280} + \frac{v^2}{823{,}900}\right) W.$$

The first and second columns of the table below give the velocity of a train in miles per hour and feet per second, respectively, while in the third is given the total resistance in pounds per ton of the weight of the train, as determined by means of the formula above.

TABLE OF TRAIN RESISTANCE AND EFFICIENCY.

Velocity in miles per hr.	Velocity in feet per sec.	Total Resistance.	Average Resistance.	Relative Efficiency.
0	0.000	7.143	7 143	0.000
5	7.333	7.273	7 186	0.026
10	14 666	7.665	7.317	0 503
15	21 999	8.316	7.531	0 696
20	29.333	9.233	7.839	0 836
25	36 666	10 041	8.231	0 927
30	43.999	11.842	8.709	0.978
35	51.333	13.526	8.275	0.998
40	58.666	15 495	9 927	0 996
45	65.999	17.707	10.669	0 981
50	73.333	20.197	11.493	0.955
55	80.666	23 305	12.529	0.910
60	87.999	25.938	13.408	0 893
70	102.66	32.723	15.666	0.825
80	117.33	40.554	18.243	0.761
90	133.99	49.427	21.241	0.702
100	148.66	59 357	24 546	0.650
110	163.33	70.321	27 561	0.604
120	177 99	82 330	32.205	0 562
130	192.66	95.383	36.558	0.526
140	207.33	109 48	41.255	0.493
150	221.99	124.62	46 302	0.464

Example.—A train weighing 800,000 pounds moves with a uniform velocity of 40 miles an hour. Find the number of pounds of coal consumed per hour.

From the table the resistance for this velocity is 15.5 pounds per ton. Hence the total resistance $R = 15.5 \times 800{,}000 \div 2{,}000 = 6{,}200$ pounds, and the energy expended per hour will be $6{,}200 \times 5{,}280 \times 40 = 1{,}309{,}440{,}000$ foot-pounds.

Assuming that the average locomotive exerts 300,000 foot-pounds of energy for every pound of coal burned, the number of pounds of coal consumed per hour will be $1{,}309{,}440{,}000 \div 300{,}000 = 4{,}360$ pounds, or about 110 pounds per mile.

In the curve $A\ B$, Fig. 1, the ordinate at any point represents graphically the resistance in pounds per ton of the weight of the train, corresponding to a velocity represented by the abscissa of the point.

The tractive power of the engine bears a definite ratio to the weight on the drivers.

Haswell gives the following values of this coefficient of adhesion as it is called:

Condition of Rail.	Coefficient of Adhesion $= f$.	
	European Practice.	American Practice.
Rail very dirty.....	0 3	0.33
Rail very wet.....	0.27	0.25
Ordinary condition.	0 2	0.222
Misty weather.....	0.15	0 2
Frost and snow....	0.09	0.16

This coefficient expresses the ratio of the horizontal force applied at the rail that will just produce slipping to the pressure of the wheel on the rail. Evidently $P = f\,L$, and the effective pulling force for any velocity is the tractive force less the resistance for that velocity; that is, the effective pulling force $= P - R$.

As the velocity increases the effective pulling force decreases till, practically, the resistance soon equals the tractive force and the velocity reaches a maximum. We may find the maximum velocity which any train can acquire from the condition $P - R = 0$.

Hence from (1) $P - (a + C\,v^2)\,W = 0$

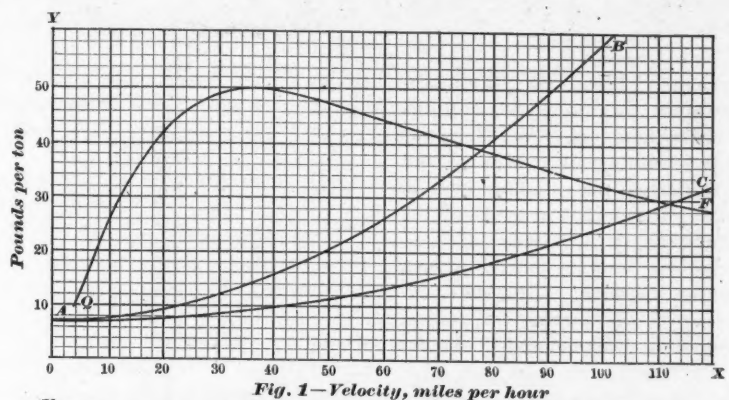


Fig. 1—Velocity, miles per hour

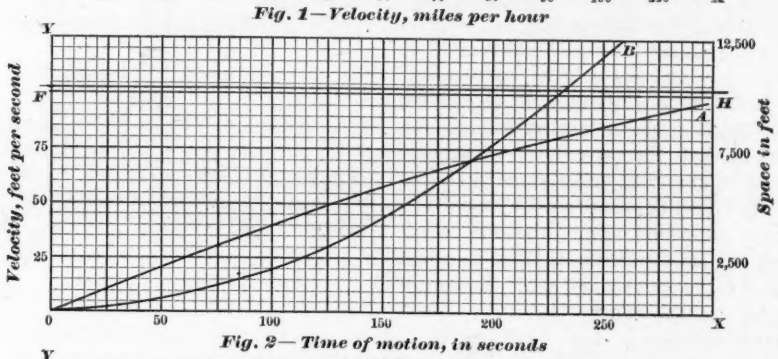


Fig. 2—Time of motion, in seconds

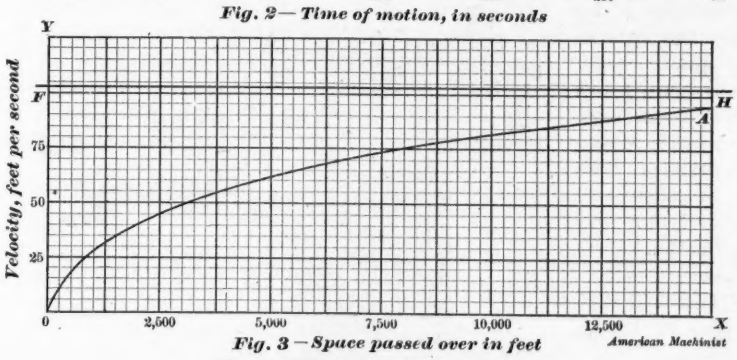


Fig. 3—Space passed over in feet

TRAIN MOTION AND RESISTANCE.

solving for v and letting $K = P - a\,W$, (2)

we have maximum velocity $= V = \sqrt{\frac{K}{C\,W}}$

$$= 907.8\sqrt{\frac{K}{W}} \qquad (3)$$

from which the maximum velocity for any train may readily be found.

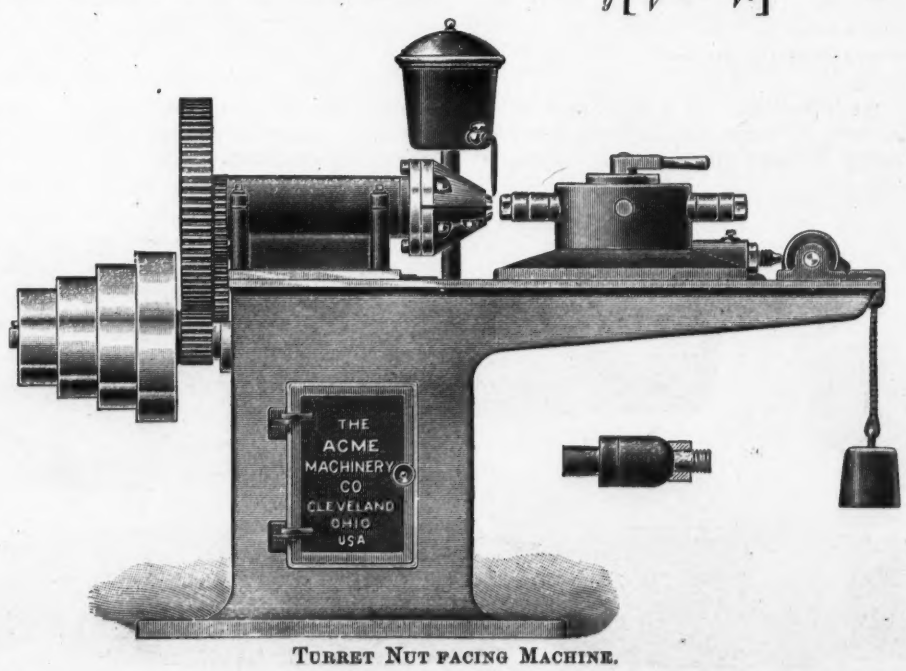
Example—$W = 800{,}000$ pounds and $P = 16{,}000$ pounds; then $K = 16{,}000 - 800\,000 \div 280$, or 13,140 pounds,

and $V = \sqrt{13{,}140 \div 0\ 000001214 \times 800\ 000} = 116$ feet per second, or 79 miles per hour.

The most economical speed for a train as far as work lost through friction is concerned, is that at which the ratio of the space passed over to the resistance overcome in a given interval of time is a maximum. This occurs when the ratio $v : R$ is a maximum. Plotting the numerical value of this ratio for different velocities gives the efficiency curve $Q\ F$, Fig. 1. The maximum ordinate occurs when $v = \sqrt{\frac{a}{C}} = 54$ feet per second, or 37 miles per hour. Letting unity represent the efficiency at the most economical speed, as far as resistance is concerned, the relative efficiencies at other speeds will be as given in the fourth column of the table. Referring to this we see that for speeds higher than 37 miles an hour, the efficiency is almost a maximum, and the train can perform a much greater amount of transportation in a given time than at a lower speed.

General equations for the time, space and velocity of a train's motion may be deduced from the principles given above; but as they involve hyperbolic functions they would be out of place here. I have, however, obtained the simple approximate formula (4) for the time required for a train to acquire a given velocity from rest, which may be found useful.

$$t = \frac{N}{g}\left[\frac{v}{V} + \tfrac{1}{3}\frac{v^3}{V^3}\right], \qquad (4)$$



TURRET NUT FACING MACHINE.

where $N = \sqrt{\frac{W}{C\,K}} = 907.8\sqrt{\frac{W}{K}}$. (5)

$O\ A$, Fig. 2, shows the form of the velocity curve obtained by solving (4) for different values of v, and for a given train, and plotting the results. The horizontal line, $F\,H$, is the line of maximum velocity, and, as will be seen, the velocity curve constantly approaches but never reaches this line, the velocity becoming practically uniform in a short time and nearly equaling the maximum velocity; so that in practice we may consider the motion as uniform after a short space of time.

The curve $O\ B$ shows the space passed over from rest by the train; the ordinates representing space, and the abscissæ as before representing time in seconds.

The curve $O\ A$, Fig. 3, shows more clearly the relation between the space and velocity. The abscissæ represent distance traveled from rest, and the ordinates the velocity acquired. These curves were plotted for a train weighing 600,000 pounds, the tractive power of the locomotive being 10,000 pounds.

As the train starts from rest, the velocity, and hence also the resistance, increases rapidly for a time; so that to find the work lost in overcoming resistance in bringing the train to a given speed, we must multiply the average frictional resistance by the space passed over. The average resistance due one ton of the weight of the train will be the average of the ordinates of the resistance curve $A\ B$, Fig. 1, between $O\ Y$ and the given velocity. This may be found, as in an indicator diagram, by drawing a number of equidistant parallel lines from $O\ X$ to the curve, measuring them, and dividing the sum of their lengths by the number of lines. Or it may be shown that for any velocity the

$$\text{average resistance} = \left(a + \frac{c}{3}v^2\right) W. \qquad (6)$$

From (6) I have obtained by plotting, the curve $A\ C$, Fig. 1, the ordinates of which give the average resistance in pounds per ton overcome in bringing a train from rest to a given velocity.

If we know the space passed over in bringing the train to a given speed, then, this multiplied by the average resistance gives the energy lost through resistance. If to this we add the kinetic energy of the train, which equals $\frac{W\,v^2}{2\,g}$ foot-pounds, the sum will equal the total energy imparted to the train. Or since the effective energy of a pound of coal may be taken at 300,000 foot-pounds, the amount of coal consumed in bringing the train from rest to a given speed will be = (kinetic energy of train + space passed over × average frictional resistance) ÷ 300,000. (7)

In bringing the train to rest from a given speed, the total kinetic energy possessed by it is lost through the friction of brakes. Hence, in stopping a train, there is dissipated an amount of energy equal to the useful effective energy of $\frac{W\,v^2}{2\,g \times 300{,}000}$ pounds of coal. This waste of energy is the same whether the train be brought gradually to rest by means of brakes, or be suddenly arrested as in a collision. In the latter case the whole force of the moving train is expended in an almost inappreciable time, merely exerting itself in destroying whatever comes in its way.

It may be shown from the laws of falling bodies that the energy expended in bringing a train to a given speed and again given out in stopping the train, would lift the train bodily to a height of $v^2 \div 2\,g$ feet.

For example.—Had the famous locomotive No. 999 been suddenly stopped when moving at its greatest speed of 86¾ miles an hour, the energy it would have expended before coming to rest would have been sufficient to raise itself to a height of $(127)^2 \div 2 \times 32.16 = 250.7$ feet.

Turret Nut-facing Machine.

We illustrate herewith a machine for facing and chamfering nuts, which has some important improvements.

The nuts to be faced are held upon arbors which are placed in the holes of the turret, and the nuts are thus successively presented to the cutter-head, which is fitted for the reception of three cutters, one of which faces, the second chamfers and the third removes the first thread in the nut. These cutters

are so formed and held as to be easily removed, ground and reset.

The form of arbor used is shown separately. There is a spherical shoulder which allows a loose collar to adjust itself and thus holds the nut true with the thread when it is faced.

The turret is indexed and held in position by a broad key and can also be clamped by a lever nut at top.

It is fed forward by a cam and drawn back by the weight seen, and the cam is turned by worm gearing, giving a very steady motion to the turret.

The driving power is ample for the largest nuts, and the range of speeds sufficient for all ordinary sizes.

It will be noted that with this machine the result of making the cutters revolve instead of the nuts is that nuts can be changed upon the arbors without stopping the machine, and its efficiency is therefore very much increased.

The machine is built by The Acme Machinery Co., Cleveland, Ohio.

Cutter and Surface Grinder—Mill Holder for Grinding.

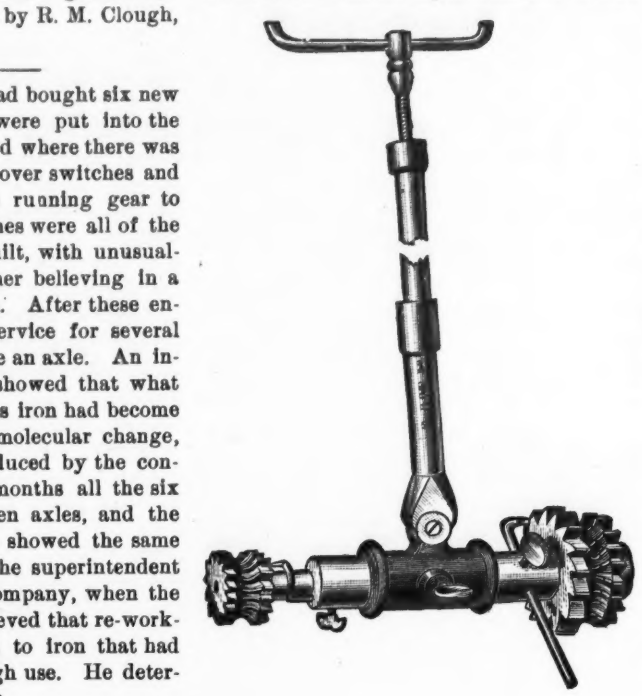
We illustrate herewith a grinding machine which will grind plain mills up to 8-inch diameter 8-inch face, and also angular mills, face mills, reamers, etc.

It is also adapted for grinding plane surfaces and will grind dies or similar work up to 10 inches long, 6 inches thick, and 6 inches wide, using a 12-inch wheel.

The spindle is hollow and will run emery wheels up to 12 inches diameter. It has a cone with two steps for a 1¾-inch belt. At the back the spindle is threaded to receive a chuck for holding mills, cutter, etc., while being lapped out, thus keeping the emery away from other machines.

The knee is moved upon the column by a screw, and the lower horizontal slide by the same means, the upper one being moved by a hand lever. The upper slide can be set at any desired angle with the lower one, and has a movement of 10 inches.

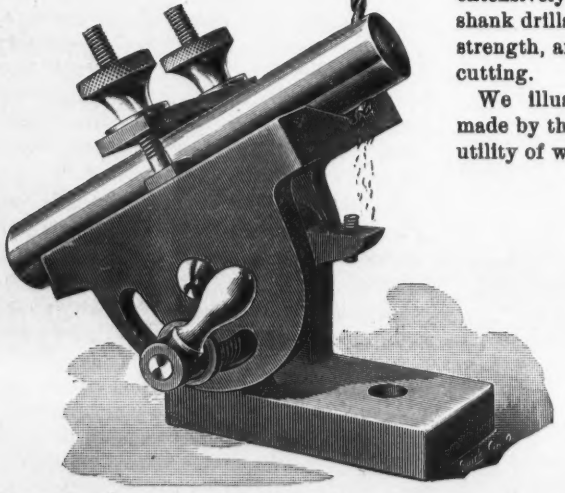
All wearing surfaces are covered and protected from emery dust and the back of column is fitted with shelves for holding wheels and parts of the machine.



CUTTER GRINDER AND HOLDER.

The smaller illustration is of a holder for milling cutters while being ground, which can be used with the above described or any cutter grinder, and is especially for grinding cutters of irregular shape.

This device is suspended from a round bar fixed above the machine, and a cutter, placed upon an arbor and fixed in the socket provided for that purpose, can be presented to the wheel in any desired manner and can be given any desired adjustment or movement.



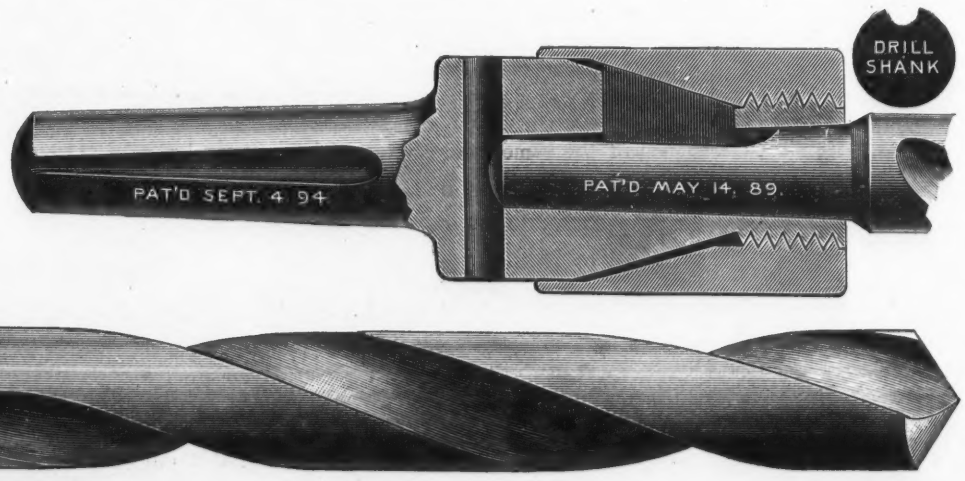
We are informed that this was devised by Mr. Stillman Lawton at a time when he had a milling contract in a small-arms factory, and that it has been used in a number of places on similar work with satisfactory results. This device and the grinder described above are made by R. M. Clough, Tolland, Conn.

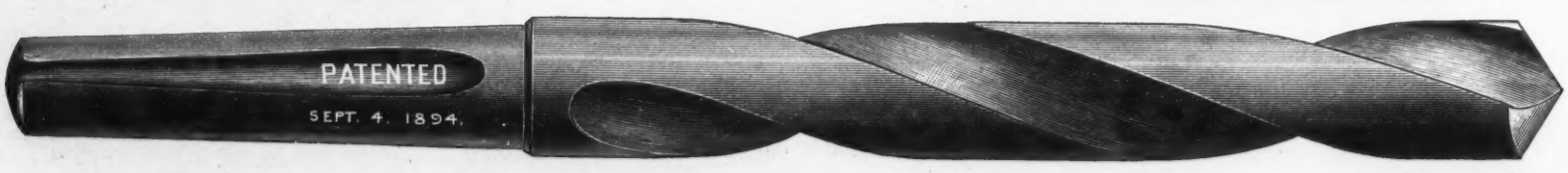
Some time ago a railroad bought six new switching engines that were put into the same hard service in a yard where there was a great deal of running over switches and frogs that subjected the running gear to severe shocks. The engines were all of the same pattern, strongly built, with unusually heavy axles, the designer believing in a good margin of strength. After these engines had been in the service for several years, one of them broke an axle. An inspection of the fracture showed that what was originally fine fibrous iron had become coarsely crystalline, the molecular change, no doubt, having been induced by the constant jars. Within six months all the six engines failed with broken axles, and the fracture in each instance showed the same condition of the iron. The superintendent of motive power of the company, when the breakages happened, believed that re-working restored the strength to iron that had become weakened through use. He determined to put the theory to a practical test, so he worked up the broken axles into piston rods, crank pins, rod straps and other parts of locomotives that are subject to severe and complex strains. The metal gave excellent service.—*National Car and Locomotive Builder.*

Improved Drill Socket and Drilling Fixture.

In our issue of November 30, 1893, we illustrated a new drill socket made by M. L. Andrews & Co., of Cincinnati, Ohio. The socket which we now illustrate, though similar and adapted for the same drill shanks, is somewhat different in construction, in having the threaded portion of the socket near the end and smaller in diameter; the ring for tightening the key being made in one piece, as shown. This socket, since our previous illustration of it, has been used extensively and is found to drive taper shank drills fully up to the limit of their strength, and it will hold a bar for undercutting.

We illustrate also a drill-press device made by the same company, the object and utility of which will be readily understood.





In the V-groove a shaft can be clamped and held at any desired angle from horizontal to vertical for drilling, stops being provided for the true horizontal and vertical positions—a device which will commend itself to any machinist. It is made in two sizes—one for light, the other for heavy work.

A British service journal says that an official estimate made by the Admiralty places the average cost of construction of a modern first-class battle ship at from £87 to £90 a ton in France and Germany, £78 a ton in the United States, and only £60 a ton in Great Britain.

It is reported from England that a new gas has been discovered in the atmosphere. This new gas is said to form 1 per cent. of common air, and to be 50 per cent. heavier than nitrogen.

An exchange says: In a remote suburb of Vienna the hatred which the poor folk entertain of bicyclists has been practically expressed. Two workmen, encouraged by a large crowd, stood in ambush near a bridge, and in the course of half an hour knocked 16 bicyclists off their machines, which were damaged at the same time. The riders took their machines on their backs, and, amid the hootings of the crowd, went to the neighboring police station.

Our New Army Rifle.

Soon the historic Springfield rifle, which, as a muzzle loader and breech loader, has played such a prominent part in the nation's wars, will have passed away into history. For the first time since this country was a nation we have set aside native talent to seek abroad for the weapon with which to arm our troops. When the English abandoned their Martini Henry two years ago, they were able to find among the inventions of this country a small arm which they then thought superior to any other, and experience thus far has confirmed this judgment. When our new arm has been subjected to the same practical tests in the hands of our troops we shall be able to judge whether or not we were wise in establishing the precedent of rejecting the product of American invention. The final conclusion of the experiments the navy are making will throw further light on this question. Our army will have a rifle with a caliber one-third (0.300) of an inch in measurement. The bore will just about admit the ordinary lead pencil, which would fit closely. The caliber of the navy gun will be still smaller. Ever since the introduction of the breech loader into modern armies the tendency has been toward a reduced caliber. England's first military breech loader, the Snyder, was 0.577 of an inch in the bore; the Martini-Henry was of 0.45 caliber, and fired a brass shell cartridge containing 85 grains of powder, and a 480-grain, or ounce bullet. Our Springfield is 0.45 caliber, with a bullet of 405 grains and a powder charge of 70 grains. Our new arm is 30 inches in the barrel, with a magazine horizontal, that is, lengthwise with the barrel. This magazine contains five cartridges, and has a cut off, so that the piece can be used as a single shot arm and the rapid fire of the magazine held in reserve, while the firing of single shots goes on at the rate of 30 per minute. The entire arm weighs about eight pounds, including a knife shaped bayonet. The bayonet is quite as great a departure from the old style weapon as is the arm. The familiar three cornered piece of steel belonging to the infantry military arms of all nations for 150 years has given way to the knife blade form of bayonet. All the European nations have adopted this pattern, with the new small bore, except Russia, and that power is seriously considering the change. The blades of the modern bayonets are from 9 to 12 inches in length and an inch wide. The American bayonet will be 12 inches long. The handles are short and straight, not more than four inches in length, and are made of wood and steel. The entire weight of the knife bayonet is about three-quarters of a pound. The sights of this rifle are adjusted to a range of 2,500 yards. Though the bullet is fatal at 3,500 yards, it has not been deemed necessary to attempt any sighting beyond the range mentioned, as anything like an accurate aim beyond this distance would be impossible

But the interest in the new arm culminates in the cartridge it fires. This weighs about one half as much as the old 0.45 70 405 Springfield cartridge. As the new arm is much lighter than the old, the soldier can carry 175 or even 200 rounds of the new ammunition without any increase of load beyond what the old cartridge gave when but 100 were carried. The charge of powder for the United States rifle is now 37 grains of a German smokeless explosive, known as the Wetteren. Something very like it will be adopted for permanent use.

This was chosen because it gave but little smoke, if any. Its burning produces a mist-like vapor, and the report is about one-half as loud as that of the service charge of black gunpowder. The bullet is about an inch long, of hardened lead, with a very thin covering of nickel or steel. In order to insure to so long and slender a missile steadiness of flight over such enormous ranges a more rapid twist in the rifle became necessary. The barrels of the new rifle have four grooves about 0.003 of an inch deep. They have one turn in about 12 inches, or 2½ complete twists in 30 inches. A long and slender bullet fired with the extreme velocity of 2,000 feet per second would not take the rifling in arms with so short a twist at all, but would "strip" or jump the grooving and leave the gun nothing but a shapeless slug of lead. In order to overcome this, the hard metal coating of the bullet was necessary, as well as the increased hardening of the lead used in the projectile.

For this reason the size of the bullet is greater than the bore of the rifle by an increase equal to the depth of the grooving, and the missile is, therefore, forced into the rifling instead of sliding over it. A proper lubricant is used with these bullets. The heat produced by this new powder is intense. Twenty rounds rapidly fired would make the piece almost too hot to handle unless the barrel was covered. The heat of the powder is much increased by the rapid friction of the hard bullet upon the inner surface of the barrel. The Germans have covered the rifles with a metallic skin, with an air space between it and the heavier metal. Other countries use a wood casing where the hand must touch the arm. The United States will adopt this method. The smokeless powder was made necessary in the new arm for several reasons. The chief one was that, even with the black powder obtainable, the inside of the barrel became so foul in a few rounds that the firing was very wild and uncertain, and there was no telling where the bullets would go. At a distance of 200 yards the bullets would be scattered all over a two-foot target, so that anything like the required accuracy became impossible. The second reason for a new powder was, that no combination of ingredients would give sufficient force to drive the projectile to the desired range. To overcome these and other disadvantages white, or smokeless, powders were used. They are a trifle more expensive than those of the old kind, but possess infinitely greater driving force. Then, too, the combustion being chiefly gaseous, the unburned residue is extremely small. The smoke given out is almost unnoticeable, and it scatters so rapidly as to produce no effect of blurring. But the new bullet is the marvel of this model invention. It is usually about four calibers in length, stiffened, as has been said. Its range and power are almost beyond belief. At a distance of 30 feet from the muzzle of the rifle fired, the bullet penetrated 24 inches of white oak, seasoned two years. At 200 yards it went through 45 inches of poplar planks, each three-quarters of an inch thick and the same distance apart. At the same distance the missile penetrated 30 inches of hard pine. At 2,000 yards it passed entirely through a horse's body at the shoulders, and at the same distance it would go through the bodies of three men. At 2,800 yards it penetrated four inches of deal planks, and at 3,200 yards it still had enough power in it to pass through a human body. These results are well verified, or they would be almost past belief.—*Army and Navy Journal.*

It is All Science, of Course.

Of late the naturalists have been losing sleep and filling a great deal of valuable magazine space in discussing the causes that produce the light emitted by fireflies. As is generally the case where much study and investigation is involved, there is a wide difference of opinion. One school of scientists trace the phenomenon to the nervous system of the insect; another to his respiration, while a third school have prepared an article of 6,000 words to prove that the light is entirely dependent upon the poor bug's circulation. The burden of evidence seems to be in favor of those who claim that the luminous tissue is made up of fat globules, which are intermittently acted upon by the oxygen of the air and the phosphorus of the creature's body.—*St. Louis Republican.*

Arms and Explosives, which is the title of an English publication, tackles the problem of the firing of a common candle through a board. Our contemporary puts the thickness of the board at ½ inch. There are probably 10,000 boys who know that a candle can be fired through an inch board, as nicely as may be. The ordinary fence board is an inch thick—a little full in the rough—and that is what the boys in this country usually try the experiment on.

A press dispatch states that the Wellman Iron and Steel Works, Chester, Pa., turned out on September 6th, the largest steel plate ever rolled. It is a rudder plate for one of the new American Line steamers being built at Cramps, and is 450 inches long, 130 inches wide, 1¾ inches thick.

"My son, observe the postage stamp. Its usefulness depends upon its ability to stick to one thing until it gets there."—*Boston Saturday Evening Gazette.*

Hardened Rollers as Pressure Bearings.

BY OBERLIN SMITH.

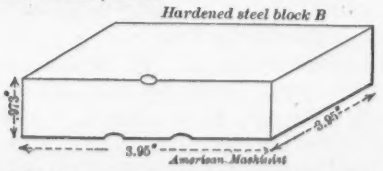
Some two or three years ago, having had in contemplation the building of a press for coining purposes with *rolling toggles*, instead of those made in the more usual way, having sliding friction acting upon their "pins," I prepared myself for the necessary designing by investigating to some extent the available pressures attainable upon convex cylindrical surfaces of hardened steel, when rolling upon plane, or upon other convex surfaces of the same material.

In doing this I prepared several blocks of an ordinary quality of tool steel, hardened in water and tempered to a straw color, which I afterward had submitted to compression tests in the large United States testing machine at Watertown, made by Mr. Emery. The respective radii of these blocks were 1 inch (marked 1 *A* in diagrams below); 2 inches (marked 2 *A*); 3 inches (marked 3 *A*); 4 inches (marked 4 *A*), and 5 inches (marked 5 *A*). Their length, parallel to their axes, was approximately 1 inch; their width, at right angles to the same, 2 inches, and their height, in a radial direction, about 1 inch. There was, as will be noticed, another block (marked 4 *B*) whose length was a little over 2 inches. The length of the working face of these blocks which formed the line of contact upon the lower or anvil block was about ¼ inch less than the figures above given, as the lower corners were beveled off at an angle of 45 degrees, the cross section of metal removed being, therefore, a right angled triangle with a base of about ⅛ inch.

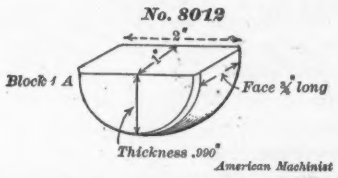
The anvil block upon which these were tested was of the same material and measured about 4 inches square by 1 inch thick.

The result of the tests in question are below copied verbatim, sketches and all, from the report of Captain Varney, Commandant of the Watertown Arsenal, and are certified to by Mr. J. E. Howard, of the same institution.

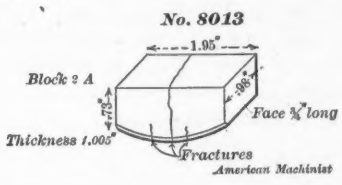
REPORT OF COMPRESSION TESTS MADE BY U. S. ORDNANCE DEPT. WITH U. S. TESTING MACHINE, AT WATERTOWN ARSENAL, NOV. 19, 1891, FOR FERRACUTE MACHINE CO., BRIDGETON, N. J.



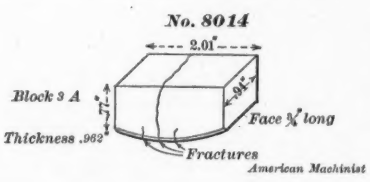
"Blocks with curved faces placed against face of rectangular piece *B* and loaded by compression.



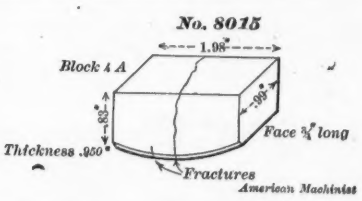
Rapid yielding of specimens at 145,000 lbs.
Ultimate strength 176,200 lbs.
Block *B* indented.



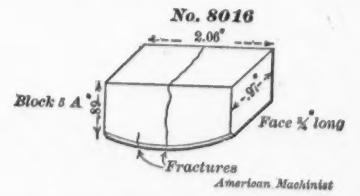
Loads applied, lbs.	Permanent set in thickness of block.	Remarks.
50,000	0	
75,000	0	
100,000	".000½	Block *B* slightly indented.
125,000	.001	
150,000	.002	
175,000	.003	
200,000	.004	
225,000	.005	
250,000	.006	
275,000	.007	
300,000	.008½	
325,000	.....	Fractured block 1 *A*.



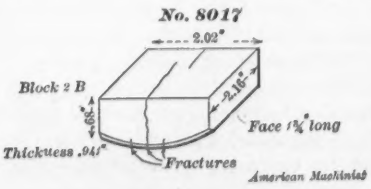
Loads applied, lbs.	Permanent set in thickness of block.	Remarks.
50,000	0	
75,000	0	
100,000	".001	Block *B* slightly indented.
125,000	.003	
142,100	.....	Fractured block 3 *A*.



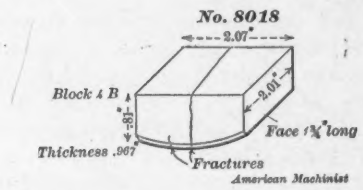
Loads applied, lbs.	Permanent set in thickness of block.	Remarks.
50,000	0	
75,000	".000½	Block *B* slightly indented.
100 000	.001	
125,000	.002	
150,000	.004	
155,380	.....	Fractured block 4 *A*.



Loads applied, lbs.	Permanent set in thickness of block.	Remarks.
50,000	0	
75,000	".000½	Block *B* slightly indented, just perceptible.
100,000	.001½	
125,000	.002½	
150 000	.005½	
175 000	.008	
183,900	.....	Fractured block 5 *A*.



Loads applied, lbs.	Permanent set in thickness of block.	Remarks.
100,000	".001	
150,000	.002	Block *B* slightly indented
200,000	.003½	
250,000	.005½	
300,000	.014½	Fractured block 2 *B*.



Loads applied, lbs.	Permanent set in thickness of block.	Remarks.
75 000	0	
100,000	0	
125,000	".000½	Block *B* slightly indented.
150,000	.001	
175,000	.002	
200,000	.003	
250,000	.005	
300,000	.008½	One end of block 4 *B* cracked through indentation made in stamping the letter *B*.

A second application of 300,000 pounds completed fracture across the block 4 *B*."

Correct. A. L. VARNEY, Capt.
J. E. HOWARD. Ordnance Dept. U. S. A.
Commanding.

It will be noticed from the above report that the specimens in question stood, before fracture, a remarkably heavy pressure, considering that this pressure was borne theoretically by a line of contact only. Of course, as the pressure increased this line practically widened to a certain extent as the upper block embedded itself elastically in the lower. The lower contact surface was then in the form of an indentation in the lower block, with an approximately cylindrical surface having a considerably larger radius than that of the upper block. The latter, of course, had a similar (reversed) contact surface, the particles of the metal being likewise distorted into a new form, the surface fitting within the lower block being that of a larger cylinder intersecting for a certain distance the small one represented by the original lower surface of the block.

Just how wide this contact surface was we unfortunately do not know, as no means were at hand to measure it. Furthermore, I do not know of any definite method for doing this having been devised, there being nothing of the kind at the Arsenal in question. I have in contemplation, however, some future tests where this important point will be taken account of, and wherein some possible methods of measuring these indented contact surfaces, which I have in view, will be tested. Of course, the maximum pressure lies along the central element of the indentation, disappearing gradually towards the edges, where it is *nil*. We therefore should naturally expect a considerably less compressive strength per square inch upon the surface in question than upon flat and parallel surfaces, as in ordinary testing. It will be seen by the report, however, that contact surfaces ¾ inch long, and of some unknown width which probably did not average ¼ inch, stood ultimate pressures varying from about 128,000 to 184,000 pounds. Now, if these surfaces had been of the same width and both flat, they would doubtless, as above intimated, have stood still greater pressures upon this area which probably amounted to less than one tenth of one square inch. If we assume this area, and that if flat it would have stood 200,000 pounds only, and if, furthermore, we assume that one square inch of metal would bear a pressure in proportion, we should have some remarkable figures, amounting to 2,000,000 pounds for the said square inch. This strength at first sight seems, of course, entirely incredible, and yet, there it was.

An interesting sequel to the above mentioned experiments was, at a later date, made at the Watertown Arsenal by giving an ordinary compression test to one of the remnants of "block 4 *A*," two of the sides of which were ground off exactly parallel for the purpose. The direction of the pressure was at right angles to that in the former test upon the same block, but as the metal seemed homogeneous this probably did not signify. The area of cross-section of this little block was about .868 square

inch, and the ultimate crushing strength 224,600 pounds. This, divided by the area, gave a strength per square inch of 258,755 pounds. Tests for permanent set were made at several different intervals, the highest being at about 200,000 pounds per square inch, but no such set was detected, thus showing the block to be a well tempered and highly elastic piece of steel.

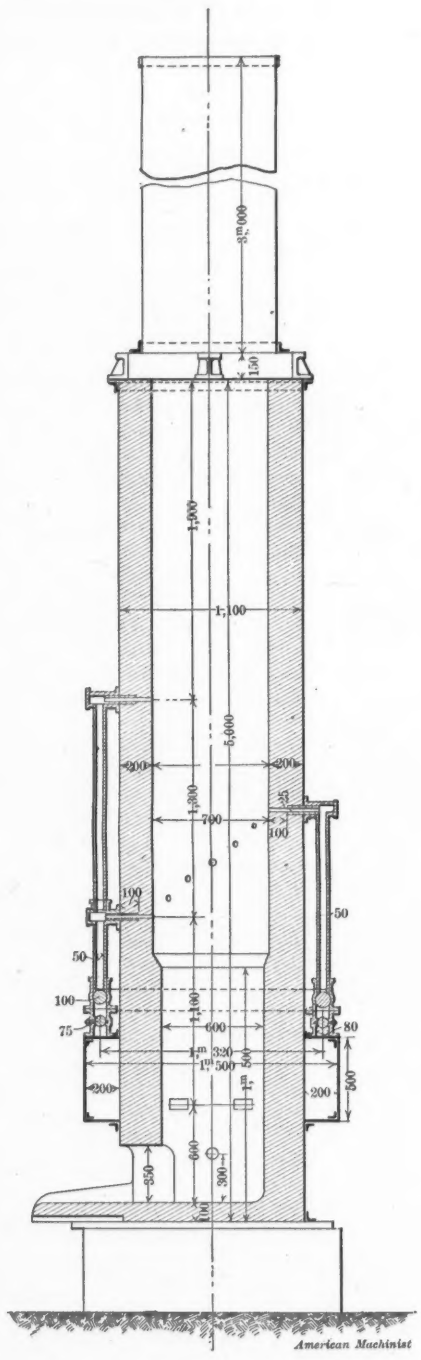
From a comparison of the results of the two sets of experiments cited, crude and incomplete as they were, it would seem as if a large block of hardened steel, with a small bearing surface, would stand pressures greatly in excess of what would usually be expected from the area in contact. Of course, there is nothing new in all this, as is testified by the knife edges of scale beams, which have an extremely small surface of contact in proportion to the pressures thereupon. The same principle is also seen exemplified in bicycle and other ball bearings where heavy pressures are taken, not upon a *line*, but upon what is theoretically only a *point* of contact. Indeed, the recorded pressures of the crushing strength of certain bicycle balls, which records I unfortunately have mislaid and cannot call to mind just now, are seemingly remarkable in comparison with what are apt to be one's preconceived ideas of the strength of such small bearings.

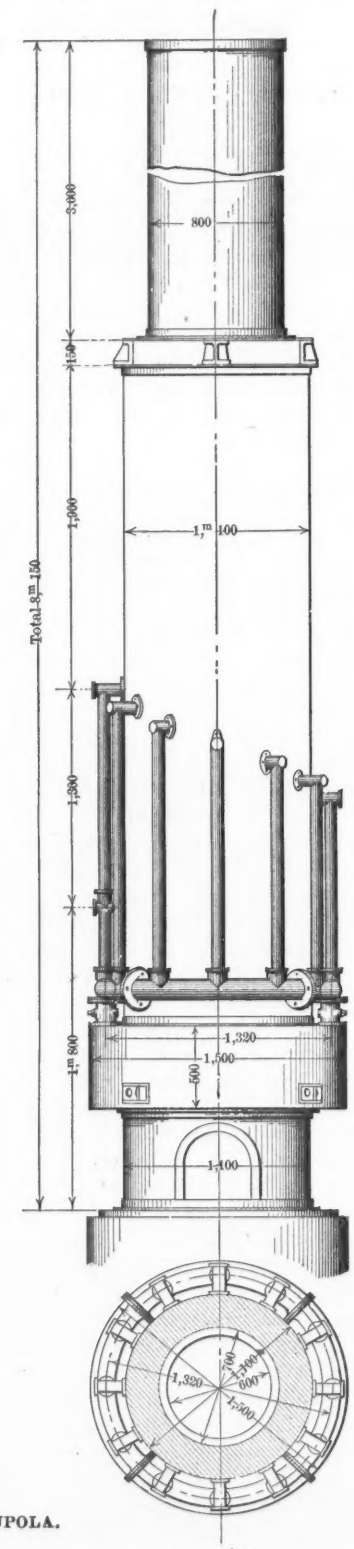
The explanation of the apparent paradox we have been considering, where the small contact surfaces in question have stood probably from six to ten-fold greater pressures than is due to the ordinary compressive strength of a short post or column of the same material, measured by its cross section, is obviously due to the fact that in the case of the rollers, and other convex objects having a tangential bearing, the particles of metal in contact are protected from flowing outwardly by being jacketed or hooped, as it were, by the surrounding metal forming the larger body of the block. We may see this more clearly, perhaps, by imagining such of the steel as lies at and near the tangent point or line (considering spherical or cylindrical surfaces respectively) to be an incompressible fluid trying to flow upwardly away from the anvil block and outwardly in all directions, but being confined and prevented from so doing by surrounding walls having a sufficiently high tensile strength to resist bursting; these walls consisting of the outer portions of the blocks of steel, which are not in contact with each other, and not subjected to direct compressive stresses. There is, obviously, no definite line of demarkation between our hypothetical fluid and its containing vessel, but the principle is embodied all the same, the stresses, of course, being in various directions and being modified in their character gradually, from the purely compressive ones at the contact points, outwardly to those which are more of a tensile nature.

I was led to consider the practicability of the rolling construction in question, which had the decided advantages of avoiding both sliding friction and the consequent necessity for lubrication by contemplating the comparatively long life of railway tracks and locomotive tires. Especially is this remarkable when we consider that both metals are soft, that the bearings are practically only from 1 inch to 2 inches long upon the convex-headed rails generally used, and that sometimes a weight of perhaps 50 tons is distributed among four or six driving wheels. The case is, of course, aggravated by the jarring, jumping and pounding of the machine when running at a high rate of speed, but even with these disadvantages the results upon all our railroads are so favorable as, in my opinion, to call for a greatly increased respect, upon the part of engineers, for rolling bearings of various kinds, wherever they can be used to advantage.

The experiments in question served the purpose for which they were instituted by convincing me of the practicability of using rollers, or segments of rollers, as in the toggle press above cited, for the withstanding of very heavy pressures. The press was built forthwith, and the result so far is entirely satisfactory, as the toggle bearings therein have been running steadily for over two years, performing the useful function of producing coin of the realm at the rate of 120 per minute without appreciable wear, and entirely without oil. I have made no test as to the actual pressure employed, but it is, of course, very considerably less per unit of contact line than the ultimate crushing pressures cited in the above report.

[The coining press mentioned by Mr. Smith and in connection with which the experiments above given were made, was illustrated and described in our issue of October 12, 1893.—ED.]





A WONDERFUL CUPOLA.

A Novel Use for Compressed Air.

At the present time compressed air is being turned to useful account in a variety of ways, one of the latest developments being its application to the cleaning of railway carriages. The dusting nozzles used have been thoroughly tested, and are said to effect a decided saving of time in cleaning carriage cushions, the average time consumed by two men, one operating one of the nozzles and the other handling the seats, in removing the dust from plush and springs of 200 seats, and cleaning them perfectly, being from 27 to 33 seconds for each seat. The air used in these tests was supplied from a reservoir at a pressure of from 60 to 90 pounds per square inch. Another test at cleaning by hand in the usual way with beaters and brushes, showed the time necessary for each seat to vary from three to four minutes, the air dusters thus effecting a saving of about 85 per cent. —*The Mechanical World.*

LETTERS FROM PRACTICAL MEN.

A Wonderful Cupola.

Editor American Machinist:

We have, sometime since, noticed several articles in your paper on cupolas.

To-day we have the pleasure to forward to you sketch of the cupolas at work in our foundry, and which, besides giving us entire satisfaction as to the quality of iron, does not consume more than 4½ kilos of coke per 100 kilos of pig-iron (charge for lighting the fire not included). The cupola is melting 2,500 kilos per hour.

It will be seen that besides the air which enters all around the melting zone, pipes are blowing air all around and over, following a spiral, and help to burn escaping gases of the melting zone. No flames escape out of this cupola when at work.

This patent apparatus of Greiner & Erpf is also used by many of my colleagues.

Should you require any further information on this subject, we shall be pleased to supply you with the same.

Bruxelles, Belgium. H. BOLLINCKX.

[The figures given by Mr. Bollinckx mean simply that this cupola, which is rather small in size (melting 5,511 pounds of iron per hour), melts 22.2 pounds of iron to 1 pound of coke, which is so far beyond any cupola performance we have ever before heard of, that it becomes a mystery.—ED.]

Formulæ for Plates.

Editor American Machinist:

I have just returned from a long voyage during which I missed the AMERICAN MACHINIST of July 19th, in which appeared a letter from Mr. Wm. Kent criticising my theory of the plates of uniform strength.

Contrary to Mr. Kent's statement, careful experiments have been made on plates of different shapes by Prof. C. Bach. The results were published in the *Zeitschrift des Vereines Ingenieure*, in October, 1890, Nos. 41, 42, 43, 44 and others, which did prove the correctness of Grashof's, Clebsch's, Laine's formulæ and my own.

Mr. Kent says that "the great excess of thickness given by the formulæ of Grashof and Rankine over that calculated by the empirical formulæ given by recent authorities on the steam engine, which latter are presumably based on actual practice, indicates that the theoretical formulæ of Rankine and Grashof are also based on incorrect hypothesis as is Guy's." I have not seen a hand-book in which it is advocated to make cylinder or tank covers and bottoms (subjected to fluid pressure), exactly flat and without ribs for diameters over 15 inches. It is known that the least alteration in the shape of the cover or bottom changes completely the directions of the forces acting upon and in the plate itself. The first part of my work treats of flat plates, not of conical, spherical, corrugated or ribbed plates. These will be analyzed later on, and will serve to conclusively demonstrate the truth of the theory in question.

If, as Mr. Kent asserts, the maximum tension in a circular plate fixed at the edge and loaded at center is at the point of application of the load, what will happen if the plate is bored concentrically and becomes a flat ring held at the outer edge and loaded along its inner edge? Will not the bending moment vary from zero at the inner edge to a maximum at the outer, whilst the shearing force will vary inversely as the radius of the plate? And by reducing the inner radius to infinity, will not the plate be full again and be subject to the application of the same laws that govern the flat ring? This question will be dwelt upon in my next paper.

Mr. Kent quotes from Wood's "Resistance of Materials" the following formula:

For uniform load $\frac{1}{24}\ W l = \frac{1}{6}\ R b d^2$.

Mr. De Volson Wood's "Treatise of the Resistance of Materials," fifth and seventh editions, page 127, equation 126, and more fully page 128, case X., reads thus: $\frac{1}{12}\ W l$ = maximum bending moment, and this corresponds exactly to the theories of Grashof, Weisbach, Reuleaux, Unwin ("Machine Design," Vol. 1, page 55, case XII.), etc.

W is the total load supported by the plate.

b = width of the plate.

l = length of the plate = 2 radii = 2 r.

p = load per unit of area of the plate.

$R = f$ = coefficient of resistance of the material.

$d = h$ = thickness of the plate.

$W = p\ b\ l$.

$\frac{1}{12}\ W l = \frac{1}{12}\ p\ b\ l^2 = \frac{1}{6}\ R\ b\ d^2 = \frac{1}{6}\ f\ b\ h^2$.

In this equation we may eliminate b without sawing the plate into three parallel parts as Mr. Kent proposes.

Then $\frac{1}{12}\ p\ l^2 = \frac{1}{6}\ f\ h^2$.

$$\frac{1}{2}\frac{p}{f}\ l^2 = h^2,$$

but $l = 2\ r$ and $l^2 = 4\ r^2$;

$$\text{hence } \frac{1}{2}\frac{p}{f}\ l^2 = \frac{2\ p}{f}\ r^2 = h^2.$$

$$\text{(a)}\ldots\ldots h = r\sqrt{\frac{2\ p}{f}} = 1.4142\ r\sqrt{\frac{p}{f}}.$$

Not only Mr. Kent's quotation from Wood's is misplaced, but his own calculations are incorrect.

Taking again the equation $\frac{1}{24}\ W l = \frac{1}{6}\ R\ b\ d^2$

we have $\frac{1}{24}\ W l = \frac{1}{24}\ p\ b\ l^2 = \frac{1}{6}\ p\ b\ r^2 = \frac{1}{6}\ f\ b\ h^2$;

$$\text{hence } p\ r^2 = f\ h^2.$$

$$\text{(b)}\ldots\ldots \text{and } h = r\sqrt{\frac{p}{f}}.$$

Comparing equations (a) and (b) with mine, we have for the values of h

(a) (b)

$$= 1.4142\, r\sqrt{\frac{p}{f}} \Big| = r\sqrt{\frac{p}{f}}$$

$$\Big| h_{max.} = 0.938\, r\sqrt{\frac{p}{f}}.$$

In the calculation of the thickness by Mr. Kent the error is evident and the advantage remains with the value of $h_{max.}$ for not only Mr. Wood's equation (126) gives a greater thickness, but Mr. Kent's alleged equation is excessive. ALBERT E GUY.

Tools and Their Uses.

Editor American Machinist:

The dictionary calls a tool "an instrument of manual operation," and an instrument, "by which work is performed or any thing effected."

I think I am correct, owing to the general understanding of the word tool, in meaning by it any kind of a contrivance by which work is done. A machinist's caliper, large planing machine, locomotive or dredging machine, I should call tools.

The locomotive or steamship builders are tool makers. The beaver does quite extensive engineering work with only the tools furnished him by nature, but man must make tools to make other tools with, and when you get right down to business to-day, is it not pretty much all a question of tools? Years ago the making of special tools did not receive near the attention of to day, and to-day will not be "in it" with a few years later.

The number of regular uses an old-time blacksmith had for his kit of simple tools was remarkable, and the amount of ingenuity possessed by some of them in discovering new uses, was still more remarkable, but the mechanic of to day does not stop at this, but dives into the invisible for new special tools when those at hand do not seem to apply. By this means the field of operation is greatly enlarged, besides most special tools will find other work that they fit, so a great many of them in time become regular all around tools.

If you wish to go to the bottom of the sea and return, you will do well to at first consult a tool maker. He will figure the pressure of the water at the depth you desire to go, and will provide you with an armor to properly resist. He will arrange other matters in a satisfactory way, and, on the whole, you will be well pleased with his work. The armies of nations years ago realized the value of tools in war, so to day, perhaps, tools in this direction are more extensive than in most any other.

The world would be in a state of barbarism without the work of the tool maker.

It is often quite a problem to decide whether the tools at hand can be used for the work, or whether the work must be designed to suit the tools, or new tools designed to suit the work.

Some will give the matter a very few minutes' thought, and decide that new tools are necessary, and then after making them, a few more minutes' thought on the old tools discovers a way that they might have been used; this sort of thing has led many men to think that they needed "kicking." A very good way to partially avoid this sort of thing is (after you have given the matter what you consider proper thought) to lay the matter before some other party, and state plainly the difficulties that have occurred to you. Different minds travel in different directions, so it is possible that the other party will see something that you failed to see. I believe that any work possible to be performed can be readily done by the use of suitable tools.

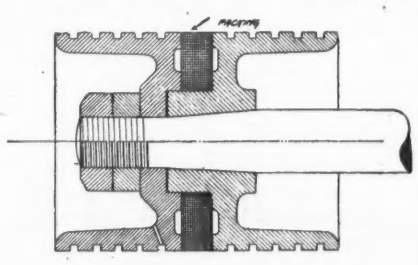
I would not exclude a trip to the North Pole.

In this weather, with the thermometer at 100, the North Pole job might be an agreeable example of the possible uses of special tools. The consideration of tools to do a piece of work has nothing to do with the object of doing it at all, so the object of going to the North Pole I need not consider. Like many other kinds of work, it has been attempted by the use of regular tools, that is, regular ships have attempted to sail there, regular men have attempted to walk or crawl there, but all regular plans have failed, so the job clearly requires special tools. It has been clearly shown that the surface of the earth at that part is not suitable for navigation by the use of regular tools. To reach that long-sought-for Pole, we must use something irregular.

The tool maker suggests a modification of the balloon. He says that a new envelope must be devised to prevent all possible leakage of gas, and that extra gas should be carried in strong cylinders at high pressure to make up for deficiencies. He says that the old plan of throwing out ballast when you wish to rise, and blowing out gas when you wish to descend, is too liable to come to an abrupt end (when the gas and ballast run out) for this job. He says that a compressor should be carried, so the navigator can force gas from the balloon into cylinders (carried for the purpose) when he wishes to descend, and allow it to escape again into the balloon when he wishes to rise, and, on the whole, the contrivance must be longer lived than those in use. He says he should travel with the wind when it went in his direction, and when it blew in contrary directions he would drop his grapnel and wait for the wind to change his way again.

The tool maker says this is only a vision, that perhaps the fancies he has put in words would not be operative, that it might require years of patient labor and great expense to perfect the tools for this job, but he believes it possible.

Mechanics are coming more to the front every day. Mechanics will discover the North Pole, not sailors. A MECHANIC.



Pump Plunger.

Editor American Machinist:

My attention has been called to Mr. Clarence Becker's communication in your issue of September 6th. Mr. Becker is in error, but I am not surprised to have him misconstrue the design of the plunger. We inclose a sketch showing exactly how the air which is supposed to lodge under the pump plungers is removed. The engraver forgot to show small opening in the cut. All of our plungers are drilled as shown in sketch, which permits the air pocketed only in the start to escape from the sides of the plunger, and is then expelled through the discharge of pump. Would like to ask Mr. Becker how long he thinks air would remain under the plunger after starting up the engine? He might be right with a slow-running pump, but with our high piston speed my judgment is that it would soon be expelled. G. F. AHRENS.

Smoke Consumption.

Editor American Machinist:

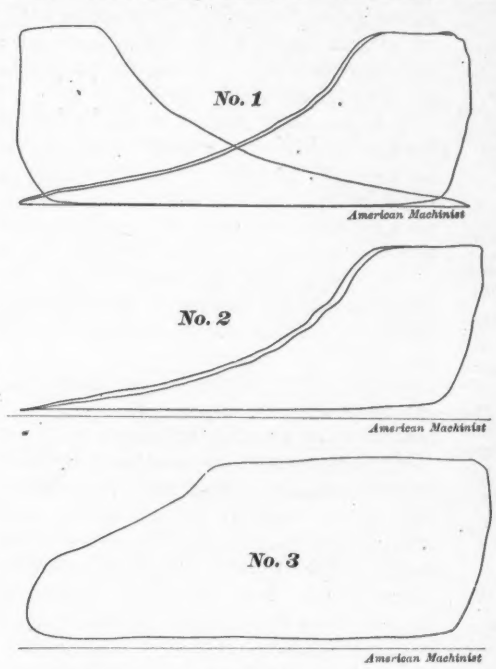
An article in a recent issue of the New York *Sun* reminded me of an article in your issue of January 11th, under the heading "How to Consume Smoke." The only perfect way is to get a complete combustion, and to accomplish this the coal has got to be prepared by pulverizing it and fed into the furnace with a proper supply of oxygen to consume the proper amount of carbon in the furnace. By the use of my direct gas generator I accomplish a perfect combustion by the decomposition of steam, and form a gas by making a destructive distillation of the atoms of carbon, or, in other words, the gas and air become heated to a high temperature by their own action, thus a more perfect distribution of heat and a complete combustion take place. Any desired temperature is attained and maintained. In a measure it can be regulated as accurately as a lamp. H. A. BRADLEY.

Effect of Position of Indicator.

Editor American Machinist:

I send with this cards taken from an 18"x42" Corliss type of engine which may be interesting.

No. 1 was taken with a side pipe ½ inch diameter, running the entire length of cylinder, with ordinary indicator cock under



the indicator at center of pipe, and an angle valve at each end of cylinder. The steam had to fill the entire length of ½-inch pipe as well as the indicator.

The pipe was taken out and the indicator cock put close to the end of cylinder and card No. 2 was the result. This engine is run with two pounds back pressure.

No. 3 shows a heavy load, and how two eccentrics handle it.

In connection with this, there was an engine running in an electric light station that gave a very faulty card on one end, admission and steam lines both being very much out. These cards were used for puzzle cards for a long time as no one could give the reason.

It was finally discovered that there was a hollow in the cylinder head and had been plugged, but the plug had got out. Plugging it again made everything all right, bringing the admission line all right, and the steam line up so that it showed the same pressure as the other end.

W. E. CRANE.

An Aquatic Flying Machine.

Editor American Machinist:

The general reader of mechanical journals is no doubt prepared to hear at any time of a successful flying machine. It seems that leading English papers have recently published such glowing accounts of Mr. Maxim's inventions in this line that the impression is made that his machine is a success. Those who have read Mr. Arthur L Stevens' article in the AMERICAN MACHINIST of September 6th will find that these reports are not true, or, at least, that the late experiments with the Maxim machine were far from satisfactory.

There can be no doubt, however, but that valuable information has been secured through the experiments of Professor Langley and Mr. Maxim, and that a flying machine is still among the future possibilities.

It has often occurred to me that inventors along this line should not aspire to such lofty heights at first, but content themselves with something less hazardous.

Let this machine be a cross, as it were, between a bird and a boat. Something with a great flat bottom like a porcelain plate, and let it be supplied with power sufficient to make it glide on the surface of water.

Ever since we were little boys we have known that a flat stone, when thrown across a sheet of water, will not sink until its velocity is greatly reduced.

It appears that Professor Langley's experiments with aeroplanes show that 1 horse-power will raise from 180 to 200 pounds into the air. We are not informed as to the velocity required to produce this result; but let that be what it may, the resistance would not be greater, we think, at the surface of water than higher in the air. The propelling facilities, at least, at the surface of water would probably more than equal the friction on the water. This aero-aquatic craft may float like a buoy when not in service, and when in motion skim over the water like a seagull.

I will venture no further in suggesting details for the construction of this chimerical craft, but will offer this as my contribution to the general fund of subjects for the cultivation of the inventive capacity.

The invention may be styled a "skipping ship." It should simply be impossible for it to mount into the air or sink in water, draw but 2 or 3 feet of water when at rest, and as a forward motion increases, this draught diminish until, at a speed of 60 to 100 miles per hour, there will be practically no draught at all, and, like the flat stone, go gliding over the water, only touching it at intervals.

But, says the mariner, "What will be done in stormy weather?" I answer: Shut up like a tortoise and ride the waves.

I am aware that many objections, both fancied and real, may be found to this plan for reaching aerial navigation, but if this is ever to be accomplished, it seems as if it must be done by gradual approaches in some such way as I suggested. "QUIRK."

On the heels of the official report certifying to the stealings in connection with Northern Pacific dealings comes the report of the institution of a suit to recover nearly twelve millions of dollars charged to have been "wrongfully appropriated" by means of manipulating Hocking Valley railroad bonds, and it is explained "how a syndicate made $11,589,000 without putting up a dollar."

The same paper contains accounts of numerous business failures attributable to increasingly fierce competition, and suicides of honest and industrious men and women discouraged at their inability to find work to do by which they could earn an honest living.

Recent events seem to be pointing to the necessity for more governmental supervision of a service which has become an absolute necessity to our modern civilization, and in which there cannot in the nature of things be free competition. This governmental interference, supervision, or ownership (whatever form may finally develop) may be looked upon as a necessary evil, but it would be hard to show that the probable evil would be nearly so great as the present system of speculation, discrimination, corruption and robbery. More rascality has been uncovered within the past few years in connection with railroad management than has been connected with the Post Office department in its entire history, and there is evidence that the people are becoming thoroughly alive to the evil and determined to right it in some way.

A boy eats two ounces of ice. Let us see what is the approximately thermodynamic equivalent of the work he has made his interior do, assuming he takes five minutes to eat it. In melting the ice, taking the latent heat of fusion at 143 units, and the specific heat the same for the coloring and sweeting admixture as for the ice, he will require 18 units to reduce the ice to water. To raise it in temperature to that of his inside, he will require 7 more units, or a total of 25 British thermal units. Taking the mechanical equivalent as 777 foot-pounds, this will be equal to 19,425 foot-pounds. If the boy weighs 100 pounds, he will have called upon his stomach to do as much heat work as would, with a machine having unit efficiency, raise him 194 feet high, or a rate of heat extraction equal to nearly an eighth of a horse-power.—*The Engineer.*

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Accidents From Exposed Machinery.

It seems almost useless to write or preach about accidents from unnecessarily exposed machinery. We may read almost every day of some one falling into an exposed fly wheel, getting crushed by a belt, caught by a set screw and carried around a shaft, getting a hand or an arm crushed in gearing, or being injured in some way by machinery; such accidents never, it would seem, are to grow less in number.

It is generally difficult to tell which is the most to blame in the instance of such an accident, the proprietor who sets up death traps or the workmen—and women—who walk into them. Of course, it is not difficult to tell who are the principal sufferers. It is a well known fact that workmen will become exceedingly reckless in such matters, taking all kinds of chances that they are not called upon or expected to take; and, on the other hand, employers will leave dangerous machinery exposed that might be covered up at a trifling expense.

While accidents from machinery are very common amongst those who know better than to take the risks they are taking, they are also numerous amongst those who from the ignorance of inexperience are unaware of the danger. For instance, not long since, we read of a little girl in a factory who lost her life through her hair being caught in the machinery. It transpired that she was under the age at which she could legally be employed in a factory. In such cases it is customary to lay the blame on the superintendent, and through him on the owners. But there are two sides to this. It is of frequent occurrence that the parents of children certify to their being older than they really are for the purpose of getting their scant earnings, which they may really need.

In some States there are fairly good laws in regard to covering dangerous machinery, but they are seldom closely enforced. In one instance, where the steam engine was in one end of the shop, the law called for its being fenced about, but the owner of the shop compromised with the inspector by drawing a heavy chalk line—a sort of death line, as it were—all around and at a little distance from the exposed part of the fly wheel.

In another instance with which the writer was personally acquainted—before the existence of any law touching the subject—a heavy fly wheel similarly situated was protected by orders of the proprietor by a substantial frame, which was easily moved back when it was necessary to come at the main belt for any purpose, and as easily slid into place. It was a notorious fact that the frame would be pushed back to take up the belt, or for some other purpose—usually at night—and not replaced, remaining off sometimes for months. This was an instance, and numerous others could be named, in which the men would not take pains to protect themselves when paid for doing so. In fact, where any machinery is protected, and it is necessary to remove the covering occasionally, nothing but rigid measures will insure its being replaced if there is any other convenient and not too noticeable place to put it.

Proprietors, superintendents and workmen alike become used to seeing mechanical death traps, and it rarely occurs to either that there is any particular danger till some one is killed or maimed, while a stranger going through the works would see the danger at a glance. With the former it is a case of seeing without seeing, just as a man may daily pass through an ordinary street in a city for years without seeing enough of the buildings to really know how they look. But if he were to pass through them once with a view to noting what manner of buildings were there, he would have a very fair idea. So around many large works, if it were made the business of some one to make a thorough inspection at regular intervals for the purpose of finding dangerous places, lives would be saved. Better than all statute law covering, or trying to cover, the dangers from machinery, is the law of humanity that would make a personal duty of such inspection.

Our Glorious Navy.

It is announced that Passed Assistant Engineer F. M. Bennett has been, by the Secretary of the Navy, deprived of a previously-granted permission to write for publication on subjects pertaining to the navy. This, it is understood, was done on account of a complaint made to the department by Admiral Greer, who is Chairman of the Light House Board, and Mr. Bennett was not heard in regard to the matter, and has no right to say a word in justification or explanation of what he may have written.

It is unfortunate that naval rules prevent any but "line officers" from having access to the ear of the Secretary of Navy, and that he therefore judges every question arising between the "line" and "staff" on what must be entirely one sided, or, as the lawyers would say, *ex parte* testimony.

It is for this reason that the grossest injustice can be done to engineer officers without hope of redress or remedy, as was shown by the decision in the Danforth case, which was simply nothing more nor less than an outrage.

There can be little doubt but that line officers fear to have the true state of affairs in the navy made known to the general public, for the American people are rather inclined to want to see fair play when their attention is drawn to the fact that there is not fair play, and it is much easier to make history creditable for naval officers when those same officers are practically the only source of information regarding naval affairs. This was beautifully brought out in our columns by Mr. Harrison during the discussion on "The Personnel of the Navy," when he gave what we think was the real reason for the loss of the "Chesapeake" as pot valiant ardor on the quarter-deck, instead of a lack of time to discipline sailors, as the history books say. And it is worth noting that whatever naval records and history may say regarding the recent loss of the historic "Kearsarge," it is a common saying in the navy (outside the "line"), a saying which will also probably become a tradition, that the loss of the "Kearsarge" was due to the same cause as the loss of the "Chesapeake."

Some day, we hope, a man, perhaps an engineer, or experienced manager of industrial affairs, elected to Congress, will bring about a thorough investigation of naval matters, and an entire reorganization of the navy upon the basis of common sense. When that is done, the loss of naval vessels through drunkenness will be done away with. Such utterly senseless and outrageous performances as that known as the Danforth case will be impossible, and men who are employed in the navy will have at least a few of the rights enjoyed by other human beings—the right to receive and to spend as they choose their own money, for instance.

An official report by Mastery in Chancery A. L. Cary, states that Henry Villard "unlawfully" made a profit of more than $363,600 by building railroads which he afterwards sold to a company that he controlled—the Northern Pacific. This $363,600 is, however, only the stealings of which there is undoubted proof; how much more was stolen it is, of course, difficult to say, but it is estimated at something like two millions of dollars.

The other day, in New York, a boy nineteen years old stole from a woman, on the street, 10 cents, and was sentenced by Recorder Smyth to over two years' imprisonment, the Recorder remarking as he passed sentence that there were "too many bad boys on the streets of New York." Sentences are not usually proportioned to the amount stolen. If they were, and provided further that Villard were to be sentenced at all, his term of imprisonment would be 7,272,000 years on this single deal, without making allowance for the fact that Villard's operations injuriously affect other railroad property by lessening faith in its honest management, and that the aggregate amount which others lose by his operations is much more than he actually stole. In the final analysis, all these stealings come out of the products of labor, *i. e.*, out of the efforts of those who perform useful service of any kind. These people will, some day, find a means of relieving themselves of such burdens, and the wonder is that they bear them so long and so patiently.

A Correction.

In our remarks on the tariff and business (issue of September 13th) we were led into the error of stating virtually that the rate of duty on imported machinery under the act of 1890 was the same as that fixed by the new law, whereas the fact is that the law of 1890 made machinery dutiable at 45 per cent., or 10 per cent. more than the present rate. We should consider such a mistake on our part entirely without excuse, were it not for the fact that we had seen what purported to be the old and new rates published in parallel columns, and given as the same under both laws for machinery, that rates on machinery are not specifically stated in either law, and that, fortunately, American machine tools, steam engines, steam pumps, locomotives, sewing machines, wood-working machinery, mining machinery, and, in fact, most lines of American machinery are articles of export, not of import, and the rates of duty imposed upon them by other countries are, therefore, naturally more discussed among machinery men than our own rates.

One class of machinery—used in jute and flax manufacturing—has been and probably will be imported extensively from England, because jute and flax manufacturing has been so long extensively carried on in that country, that, naturally, they make a specialty of machinery used in it.

Literary Notes.

VANDEGRIFT'S UNITED STATES TARIFF—1894.

We have received from F. B. Vandegrift & Co. (27 William street, New York, and 50 South Fourth street, Philadelphia), a paper-covered book, which contains complete the Tariff bill which recently became law. The law is fully digested, with over 12,000 articles, giving the rate of duty, paragraph of the law and decisions of the courts, general appraisers, and treasury department; also, a complete list of articles on which drawback has been allowed, with the amount of wastage. Also a table of foreign coins, with values as proclaimed by the director of the mint, a foreign express tariff, the administration law, and other law on the administration of the customs service.

This, it will be seen, must be a very useful book to all interested in exports or imports, and all who wish to have at hand a reference book on this subject.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(444) M. S, Pottsville, Pa. Your question is out of our line. We have had no experience in the line of work to which you refer. You will probably find all the information you seek in the treatise on the electro deposition of metals, by Dr. George Langbein, published by Henry Carey Baird & Co., Philadelphia, Pa.

(445) N. D., Harrison, N. J., writes: Kindly advise me which is the best engineers' pocket book. I was about to purchase Trautwine's in preference to Haswell's, but I will wait for your advice. *A.*—Both are excellent books. Trautwine's is more suit-

able for civil engineers, and Haswell's for steam engineers. For general practice get both.

(446) T. S., St. Louis, Mo., writes: Kindly inform me where I can get text books on mining machinery and engineering, especially books treating on gold and silver ore. *A*—John Wiley & Sons, 53 East Tenth street, New York, and Henry Carey Baird & Co., 810 Walnut street, Philadelphia, Pa. 2. Please name some of the manufacturers of hydraulic and steam mining machinery. *A*.—See our advertising columns.

(447) H. P. H., South Bay City, Mich., asks: Where can I obtain lines for a good boat about 37 feet long? *A*.—You can obtain these from H. J. Gielow, engineer and naval architect, Broadway, New York. 2. What size engine, fore and aft compound, will I need for this boat to run it at a reasonable speed? *A*.—That depends on the purpose for which the boat is to be used. If you intend to use it as a sea-going steam yacht, the cylinders should be 5 and 10 inches diameter and 7 inches stroke. These dimensions should be taken as an approximate estimate only. 3 I intend to use a Roberts' boiler; what size will I need? *A*.—It will be more satisfactory to you to get the size from the builder. 4. What kind and size of condenser will be required? *A*.—Surface condenser with about 45 square feet of cooling surface.

(448) L. S. E., New Orleans, La., writes: We are running our plant by an electric motor, and we have a countershaft $2\frac{7}{16}$ inches diameter, making about 150 revolutions per minute. We have had a great amount of trouble with the heating of the bearings. There are a number of heavy belts on the shaft. Please inform me as to where I should look for the cause of the trouble. The shaft is in line, and we are lubricating it with hard journal grease. *A*—It is possible that the trouble is due to an impure lubricant. Try another kind. If there is no improvement, then the pressure on the journals is too great, and the bearings will have to be made longer. It is possible that the belts are tighter than they should be. In that case they should be lengthened, which may reduce the pressure on the journals sufficiently to prevent heating.

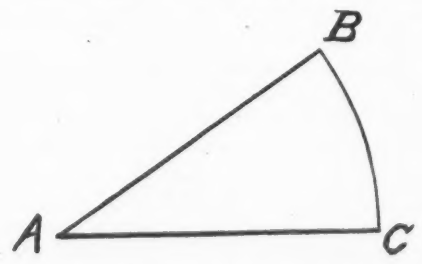
(449) H H. B., New York, writes: Please inform me where I can learn algebra and geometry. The fees must be moderate, and about two lessons per week should be given. *A*.—You can learn these branches of mathematics in the Cooper Institute without any cost. Some of the young men's Christian associations also give lessons in these branches at a very moderate cost. If you have the ability to learn algebra and geometry we cannot see anything that will prevent you from learning them yourself without a teacher; they are very simple studies Take geometry first, and make sure that each step is thoroughly understood before taking up the next one. With a little patience and close study you are bound to succeed. If you make the attempt of home study we should advise you to get the same books that are used in the public schools, by so doing you can probably get the assistance of some of the scholars, or take private lessons of one of the teachers.

(450) S. L., Brookville, Pa., writes: Some time during this year's publication of the AMERICAN MACHINIST you published a series of articles treating on mechanical drawing for beginners and suitable for self-instruction. What I want to ask is: Have these been published in book form? Also name a few books treating on mechanical drawing suitable for self-instruction, and where they may be obtained. *A*.—We have not published during this year any articles treating on mechanical drawing. You probably refer to the series which were completed in 1890. These have not yet been published in book form, but they are expected to be. This series of articles comprise 92 papers, which we can send to any address in the United States for $5.00 postpaid. "Mechanical Drawing," by Prof. C. W. MacCord, published by Wiley & Sons, 53 East Tenth street, New York; "Machine Drawing and Design," by William Ripper, published by D. Van Nostrand Co., 23 Murray street, New York, and "Practical Draftsman," by Henry Carey Baird & Co., Philadelphia, Pa., are considered to be good books. We would advise you to examine them before buying, as we do not know which will suit you best.

(451) B. C., Brooklyn, N. Y., writes: In a recent article on drawing I have seen described the old method of projecting in the first angle. Is it not a fact that most all of the technical schools and the best shops make the projections in the third angle? *A*.—Some authorities advocate the use of the third angle for making the projections, but it is not true that this is the general practice. On the contrary, the general practice is to make the projections in the first angle. In shops very little, if anything, is heard in regard to the angle in which the projections are made. Although working drawings are made in accordance with the principles of projection, draftsmen do not always observe the rigid laws and refinements and conventionalities of orthographic projections, but will follow such modifications as will best suit their convenience, and such as will be conducive to rapidity of making the drawing, and which will show the workman clearly what he has to make. Such a drawing will answer every purpose for which it was intended, and it makes no difference whether the projections were made in the first or third angle. It is on this account that occasionally we meet with working drawings in which the projections appear to have been made in the third angle. See answer to Question 315 in our issue of July 5th, current volume.

(452) L. C. S., Sacramento, Cal., writes: Please inform me if I am right or wrong in regard to the following subject: We have had a driving pulley and a loose one cast here; they are extra heavy, in fact, too heavy to suit me. They are 6 feet in diameter, and 26 inches face. Each weighs 2,625 pounds; a double belt 24 inches wide is to be used. After the pulleys were cast, I examined them, and found the arms cracked in one of them. I suppose this was caused by shrinkage; my opinion is that the arms and rim cooled first, and the hub after. The hub is 28 inches long, and 14 inches diameter, and cored out for a 6-inch shaft. This is too large to suit me. I also believe that this size of hub in the fast pulley should have been split in three parts so as to relieve the strain on the rim, and wrought iron bands shrunk on each end of the hub after the pulleys have been placed on the shaft. Please give me your opinion. *A*.—The hubs are too large, for the fast pulley we should make the hub 12 inches in diameter, 14 inches long There is no objection to a length of 28 inches for the hub in the loose pulley, but with this length its diameter can be reduced to 11 inches. You are correct in regard to the cause of the arms cracking. There is no particular necessity of splitting the hub in three parts, and shrinking bands on each end. 2 Suppose the hub of the loose pulley had been split in three parts, how would you arrange it for babbitting? *A*.—We should cast pockets in each part of the hub to receive the babbitt metal 3 Will four bolts $1\frac{1}{4}$ inches diameter in each hanger, one on each side of the pulley, be enough to withstand the pull of the belt, weight of shaft and pulleys? The shaft is 10 feet long, and drives a lot of wood-working machinery. *A*.—Yes.

(453) A. M., ——, asks: How can I determine the number of degrees in an angle made by two straight lines? *A*—The number of degrees can be determined by a protractor, which is simply a thin piece of horn, wood or brass made in the form of a semi circle, whose semi-circumference is divided into 180 equal parts each part representing one degree. This protractor is laid in position so that its straight-edge or diameter will coincide with one side of the angle, and the center of the diameter coinciding with the vertex of the angle. The number of degrees on the protractor which lie between the two sides of the angle, or, in other words, between the two lines which form the angle, will be the



required number of degrees. These can also be computed as follows: From the vertex of the angle, and with any radius, draw an arc between the two sides of the angle; divide the length of this arc by the length of the radius, and multiply the quotient by 57.292 degrees, the result will be the required number of degrees. Or, in symbols,

$$\frac{a}{r} \times 57.292 = n, \qquad (1)$$

in which a = length of arc, this may be obtained by means of a steel flexible rule; r = length of radius (if a is taken in inches, r must also be taken in inches) and n = number of degrees. If, for instance, we find that the length of the arc is 15 inches and the length of the radius is 6 inches, then we have

$$\frac{15}{6} \times 57.292 = 143.23 \text{ degrees.}$$

This rule is based on the following principles: The circumference of a circle contains the radius $2 \times 3.1416 = 6.2832$ times, and since the circumference contains 360 degrees, the radius must represent $\frac{360}{6.2832} = 57.292$ degrees. Hence, if we know the length of the arc subtending a given angle, and also know its radius, we simply find how many times the arc contains the radius and multiply the result by the number of degrees which the radius represents. 2. How can I lay off an angle containing a given number of degrees. *A*.—The simplest way will be to use a protractor. Lay the center of its straight edge on the point A (see accompanying figure), and let this edge coincide with the line A C, then lay off the point B coinciding with the required number of degrees, as indicated on the protractor, and draw the straight line A B. This angle can also be laid off without the use of the protractor. From formula (1) we deduce

$$a = \frac{n}{57.292} \times r, \qquad (2)$$

in which the letters denote the same quantities as above. According to this formula, we simply find the length of the arc a, subtending the angle, by dividing the given number of degrees by 57.292 degrees, and multiplying the quotient by the length of the radius, the result will be the length of the arc sought. To show the application of this formula, let A C be a given line, it is required to draw a line, A B, making an angle of 30 degrees with A C. From A as a center and with a radius of, say, 6 inches, draw the arc B C. The length of this arc will be according to formula (2),

$$\frac{30}{57.292} \times 6 = 3.14 \text{ inches.}$$

Now make the length of the arc B C equal to 3.14 inches and join the points A and B by a straight line, which completes the problem.

(454) L. B. M., Vicksburg, Miss., writes: I have a logarithm table of numbers from 1 to 10 000, but I do not know how to use it. Please explain how I can multiply and divide with the aid of logarithms? Also, how to extract roots, and raise numbers to any given power? *A*—To multiply by means of logarithms: Find the logarithms of the numbers which are to be multiplied together, add these logarithms, and find the number corresponding to the resulting logarithm, which will be the product required. To illustrate the application of this rule we shall take a very simple example, one for which logarithm would not be used as it can be done quicker by ordinary multiplication, but which will show clearly the principles involved. Let it be required to find the product of 28 multiplied by 24 Look in the table for the number 28 in the column generally headed by the letter N; opposite to it on the same line you will find its logarithm 1.447158. In a similar way we find the logarithm of 24 to be 1.38021. Now according to the given rule we have,

log. 28	1.447158
log. 24	1.380211
	2 827369

This sum is the logarithm of the product. Now look for the decimal part in the table, and opposite you will find the number 672, which is the answer required. Division by means of logarithm: Find the logarithms of the dividend and divisor, and subtract the latter from the former; then find the number corresponding to the resulting logarithm, and it will be the quotient required. Let s again take a simple example divide 2 580 by 12. The logarithm of 2 580 is 3 411620, and the logarithm of 12 is 1 079181. According to rule we have,

log. 2,580	3.411620
log. 12	1.079181
	2.332439

Looking for the decimal part of this result in the table, we find the corresponding number 215 which is the answer required. Logarithms are most useful for raising numbers to given powers, or for extracting the roots of numbers. Raising of powers by means of logarithms: Find the logarithm of the number and multiply it by the exponent of the power; then find the number corresponding to the resulting logarithm, and it will be the number required. Find the fifth power of 9. The logarithm of 9 is 0 954243, hence according to rule we have,

log. 9	0.954243
	5
	4.771215

The number corresponding to this resulting logarithm is found by the table to be 59,049, which is the power required. Extracting roots by means of logarithms: Find the logarithm of the number, and divide it by the index of the root; then find the number corresponding to the resulting logarithm, and it will be the root required. Find the cube root of 4,096. The logarithm of 4,096 is 3.612360. According to rule we have,

$$\frac{3.612360}{3} = 1.204120.$$

The number corresponding to the resulting logarithm (1.204120) is 16, which is the root sought. We have here assumed that an explanation of the manner of finding the logarithm of a number, or the manner of finding a number corresponding to a given logarithm accompanies your table. If not you will find the whole subject explained in any good elementary geometry, for instance, Davies' "Legendre," or Loomis' "Elementary Geometry," and several others. 3. Please name some good books on mathematics and steam engine construction, etc., that would be most useful to one who is trying to learn all he can of the higher mechanics. I am very good in the high grade public school arithmetic. *A*.—"Applied Mechanics," by A. Jamieson; and the "Catechism of the Steam Engine," by J. Bourne, are good books and may be of great aid to you.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gears, Lex'n, Phila., Cleve'd. See page 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

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Model Locomotives. Complete sets castings N. Y. Central Standard up to date. Rough or finished. G. H. Olney, 163 Herkimer St., B'klyn., N. Y.

Wanted—Mechanical, elec., civil engrs., draftsmen; no conflict with regular duties; no canvassing; tech. work. Edwin Guthrie, Washington, D.C.

For Sale—One Richards' steam engine indicator in first-class condition, cheap. American Fire Engine Co., Cincinnati, O.

Gas manufactured continuously in any quantity or quality for heating and illuminating by the Bradley's direct gas generator. H. A. Bradley, 20 Nassau St., New York.

Emery, emery wheels, grinding machines and grinders' supplies, quick process and large stock. When in a hurry, buy of The Tanite Co., New York City, Cincinnati, Ohio, and Stroudsburg, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Rustless Coatings for Iron and Steel.*

BY M. P. WOOD, NEW YORK CITY.

TINNING AND ENAMELING METALS, LACQUERING, AND OTHER PRESERVATIVE METHODS.

The protection of iron and steel used in engineering, structural and art work from the corrosive action of the atmosphere, as well as from air charged with the fumes of many industrial and chemical pursuits, and the fact that the usual coating with paint proves so ineffectual to guard from rapid decay, even when periodically renewed, has long attracted the attention of inventors and experimenters, as well as the best efforts of many chemists and scientists.

The latter, with all the resources of well-equipped laboratories, have not been much,

*Presented at the Montreal meeting of the American Society of Mechanical Engineers.

if any, in advance of the less favored experimenter who develops his ideas by main strength and awkwardness, though the fact or process once brought to light, the work of the savant is acceptable in proving the *rationale* of the same.

Fredric S. Barff, of Kilburn, County of Middlesex, England, and George and A. S. Bower (father and son), of St. Neets, County of Huntington, England, were the first to practically coat wrought iron, steel, and cast iron with a magnetic oxide, forming at the cost of the metal itself the protective layer, which is usually formed from paint. This is the process known as the Bower-Barff that was developed in England about the year 1875.*

The process, in brief, consists of placing the articles to be coated in a muffle, heated to approximately 1,000° Fahr., and when they have attained this heat, either by extraneous firing of the muffle, or by passing producer gas or the products of combustion through the muffle and amidst the articles contained, or by both methods named, steam superheated to the temperature of 1,000° Fahr. is then admitted to the muffle, and the formation of magnetic oxide begins at once. The heat of the muffle decomposes the steam, setting hydrogen free, which can be utilized to assist in maintaining the heat of the muffle; the oxygen uniting with the iron to form Fe_3O_4, or magnetic oxide. The period of exposure is from five to twenty hours, according to the size of the articles and depth of coating required, which varies from $\frac{1}{100}$ to $\frac{1}{10}$ of an inch, and can be continued almost indefinitely, or until all moderate thicknesses of iron are resolved wholly into oxide. A very able presentation of the full process was made to this society in a paper read by Mr. George W. Maynard, and found in "Transactions American Society Mechanical Engineers," 1884, Vol. IV., page 351. The color of the magnetic oxide so formed is a dull blue-black; the coating is tenacious, though when broken through by drilling, shearing, or mechanical injury, oxidation of the injured surface proceeds more rapidly than in untreated articles.

The high heat and intermittent character of the process is destructive to the retorts or muffles, and the process is necessarily prohibitory to all articles requiring cutting qualities. Its application to firearms instead of the customary bluing or browning by acid was not a success, too much attention being required to prevent the springing or distortion of the barrels, and removing the deposit formed in the bore, though it has been employed to some extent in the fittings of firearms. Articles distorted in process can be re-heated to a low red or black heat, and re-straightened without injury to the coating. The process materially weakens the iron or steel articles coated, not only by the amount of material changed from a metal to a metallic oxide or metalloid, but suffers a further loss of strength, particularly in wrought-iron, by the burning out of the cinder in articles long exposed to the heat, making what rollers and forgers call "dry iron." A further difficulty appeared in structural work held in place by rivets; the heat necessary to form the oxide caused the loss of set in the rivet. If riveted together after oxidizing the parts, the rivet had no protection from corrosion, and Muntz or gun-metal connections became necessary. The coefficient of elasticity between the oxide and the metal from which it is formed, is so nearly the same, that railway bridge members and car truck frames are comparatively unaffected by long periods of service under compression, tension, and vibratory strains. The process applied to the pipes and iron work exposed to the action of mine, sulphurous or acidulated and sea water appears to give that protection from rapid decay so long desired by those who "churn" those liquids. The data concerning the cost of application of the process are very unsatisfactory. So much depends upon the size of the articles, depth of coating, whether the furnace or muffle is operated continuously or not; but it must be an expensive process per pound or square foot on account of the skilled labor and superintendence required, setting aside the expense of superheating the steam required to the necessary temperature of 1,000° Fahr.

None of the parties using the process appear to be at all anxious to recommend the adoption of their steam superheating device, or to flit their tales of woe about the same. Costs given range from $5 to $20 per ton of articles treated, but there are many situations in which the protection given by this process would bear an addition to these figures. The amount of steam required, if used alone for the oxidizing element, and for coatings of a moderate thickness, is determined to be, for each pound avoirdupois gain in weight of iron

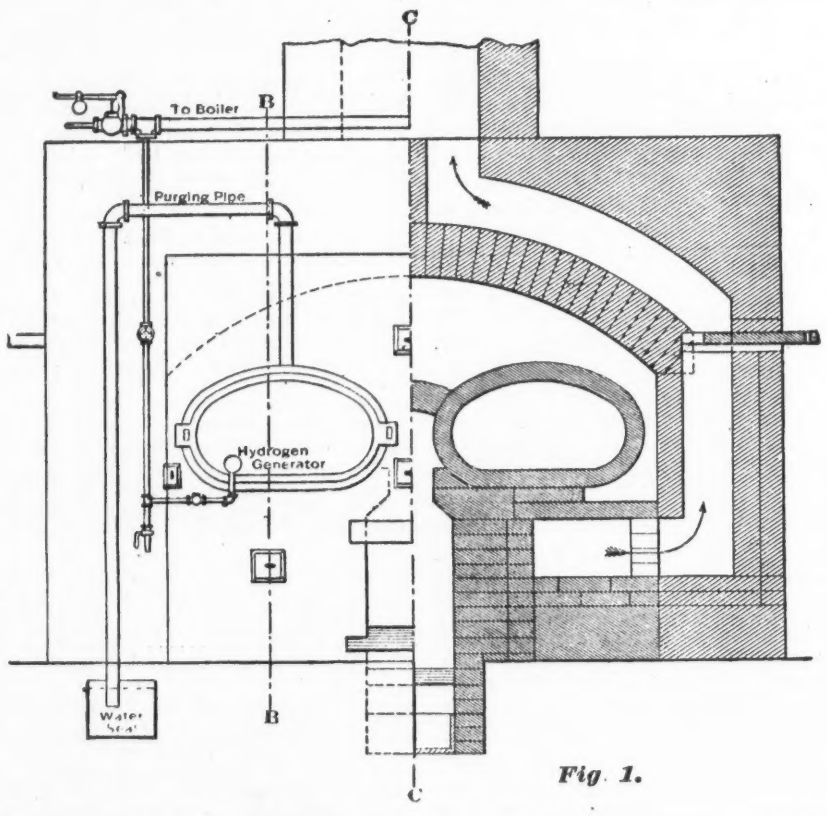


Fig. 1.

oxidized to form the magnetic oxide, 232.9 cubic feet of hydrogen weighing 2 pounds was set free, making 3 pounds of steam or 75 cubic feet at or slightly above atmospheric pressure.

The above is the theoretical amount needed to furnish the oxygen; in practice from 25 to 33 per cent. more was passed through the superheater and muffle to get results. The deeper the coating the more steam was required. If 1,000 square feet of surface was exposed for oxidation only $\frac{1}{64}$ inch thick, it equaled 625 pounds of magnetic oxide, and would require at least 2 500 pounds, or 62,500 cubic feet of steam to be furnished in about six hours, or approximately 17 horse power per hour. The patents for the process, if not expired by limitation or by the non use requirements of foreign patent laws, are rendered of small value except in special cases by more recent improvements in the art by several inventors, one of which is a matter of record in this society, and is of interest aside from its cheap and effective application by not being patented, the inventor by publication having given its use to the public.

The paper No. 180 presented to this society by Wm. H. Weightman, "Transactions A. S. M. E., 1886," Vol. VI., page 351, embraces a report by Lieut. Col. A. R. Buffington, Ordnance Department, National Armory, Springfield, Mass., to the Chief of Ordnance, U. S. A., Washington, D. C., fully describes the process, which is peculiarly applicable to finished surfaces of iron and steel, notably firearms and kindred work; the process being conducted at so low a degree of heat as to not affect tempered parts of the arm.

Finished surfaces of cast-iron are given a bronze colored coating which sustains mechanical injury, such as a blow without cracking the coating or affecting its protective power. The apparatus for armory work consists of a common cast-iron vessel or open mouthed pot, deep enough to receive the longest piece to be treated (a gun barrel immersed vertically) and large enough in diameter to contain a dozen or more barrels arranged on a movable rack capable of being raised and lowered into the bath of melted nitre, which contains a small percentage of peroxide of manganese. A brick furnace is built around the nitre pot, and a coal fire maintains the heat of the mixture, which is hot enough to ignite and maintain combustion in a pinch of sawdust scattered over the surface, or about 650° Fahr. The articles polished but not burnished or unduly raised in lustre, are simply immersed and moved about in the bath for a given time, or until the requisite color is obtained, which can be ascertained by raising the articles out of the bath and re immersing them any number of times until the color is right; then they are removed, cooled in the open air to about the temperature of boiling water, then plunged into hot water to remove the nitre, and then into a sperm oil bath to complete the process.

The nitre used must be refined, the commercial article not giving uniform results. Articles not taking the desired color on the first application, or which bear a streaked or spotted appearance from some peculiarity in the metal, are corrected upon a second application. Care must be taken to prevent the introduction into the bath of water, oil, wood, or any carbon or combustible matter. The nitre mixture is not explosive, even when poured into the open fire, but in this case the arising fumes are suffocating and dangerous. The simple and inexpensive plant, the economy of time, labor and material, the uniformity of product and the beautiful color mark this process an important advance in the art. I have been unable to learn of the application of the process to any large unfinished members of architecture or other structural bodies, but I see no reason why it should not be as effective in these cases as it is in the hundreds of small articles comprising horse furniture and saddlery fittings, general hardware, and articles made of malleable iron, wrought-iron and drop-forgings, which are on sale nearly everywhere.

The Journal of the Society of Arts has a translation by Mr. Fredric W. North, of a paper read before the Paris Socie é d'Encouragement, by Mr. Octave de Rochefort-Lucay, on the new Bertrand processes for coating with magnetic oxide, and enameling iron and iron carburets, and on a new process of tinning for cast iron, that are of interest as being possibly more simple and effective than the Bower Barff process, and are evidently based upon a new discovery in chemistry which may be thus stated: If a thin adhesive film of another metal is formed on a steel wrought or cast-iron body, and this article be then heated to 1,000° Fahr. and exposed to a current of oxidizing gas, the oxygen penetrates through the film, oxidizes the body metal, and forms magnetic oxide. The formation of this oxide continues indefinitely, the thickness increasing according to the period of exposure to the oxidizing current, provided the temperature remained at about 1,000° Fahr. The film of metal deposited in the first instance disappears in some obscure way, forming oxides which mingle with the magnetic oxide or volatilize according to the nature of the metal of which they are composed. M. Bertrand's experiments to find the best metal for depositing the primary coating, led him to select bronze (a mixture of copper and tin), which gave perfect satisfaction, and for depositing it upon the articles to be coated with oxide, he uses electricity or wet baths and sulphophenolic acid.

The following is the method adopted by M. Bertrand for an oxidation: The article cleansed (which is indispensable) is dipped a few moments in a bath containing a solution of sulphophenate of copper and tin, a slight coating of bronze is formed, the article is immediately washed in cold water and dried with sawdust, then placed in a furnace. Oxide forms, and at the end of fifteen or thirty minutes (according to the size of the article) it is sufficiently oxidized, the coating formed varying from $\frac{1}{10}$ to $\frac{1}{5}$ of a millimeter for these exposures; longer periods give thicker coating to any desired extent. M. Bertrand uses an electrical current to determine if the coating is of uniform and sufficient thickness.

The wires leading from the poles of an ordinary galvanic battery are fitted with a bell arranged to ring when in circuit. If on application of the wires to the article being coated the bell rings, the current passes, showing the oxidation is insufficient; if the bell is silent, the oxide is of sufficient thickness to insulate the object and to practically protect it.

PROCESS FOR TINNING CAST IRON.

The coating of cast-iron surfaces with tin is one of the most unsatisfactory processes connected with the mechanical arts. M. Bertrand also uses sulphophenolic acid to obtain a durable coating of tin on cast-iron. A bath is formed of water and the acid in which salts of tin is dissolved in the ratio of 1 per cent. of tin salt and 5 per cent. of the acid. The article to be tinned, previously cleaned, is dipped into this mixture and is at once covered with an adherent coating of tin, which can be afterwards polished on ordinary buffing wheels of wire and cloth, and a result obtained which is at once cheap and effective.

PROCESS FOR ENAMELING CAST-IRON.

The records of the Patent Office show many formulæ for compositions and designs of furnaces used in the process for enameling cast iron. But few, if any, of either the compounds or furnaces materialize on application, generally leaving the party to his own devices for accomplishing the desired results. There are only two processes by which a satisfactory enameled surface can be given cast iron.

In the first, or hot process, the iron, heated to a bright red, is powdered by a sieve with a flux powder (the borosilicate of lead), then heated until the flux fuses, and is then powdered with a more fusible flux, forming the glaze of the enamel. This is the only direct enameling process, and is dangerous to the operator, expensive in application, difficult to apply to large articles, nor does it allow of decorations. The second process consists of coating the cast iron with a kind of pottery, by three distinct and successive operations in the furnace.

In the Bertrand process the article is first

*See the United States patents—To Fredric S. Barff, No. 182,148, September 12, 1876, Protecting iron surfaces. Described in the "Official Gazette," Vol. X., page 443. To George and A. S. Bower, No. 234,524, November 16, 1880, Coating iron with oxide. Described in the "Official Gazette," Vol. XVIII., page 1147. No. 270,004 January 2, 1883, Depositing metals upon the surface of iron and steel coated with magnetic oxide. See "Official Gazette," Vol. XXIII, page 440. No. 270,005, same parties, same date, for a furnace used in connection with the process.

coated with the magnetic oxide as described above, then brushed over or dipped cold into the borosilicate of lead, colored with metallic oxides, to which is added a little pipe-clay to give the bath more body. The article thus covered is put into the furnace, the enamel adheres and vitrifies at the ordinary temperature used by enamelers. By putting a coating of colored enamel with a brush on the first plain coat of enamel, it is possible to make any desired decoration, which may be burned in at one operation. The process is particularly adaptable for out door vases, statuary, columns, railings, balusters, etc. The results due to the first oxidation with magnetic oxide are remarkable as much for their color as for the tenacity of the enamel and its resistance to rough usage. The process is adapted to articles of any size or shape, is not dangerous to apply, and is comparatively cheap in application. The back numbers of the *Scientific American* contain some valuable suggestions and information upon the above and other processes for the protection of iron, for which the writer cheerfully renders acknowledgment.

A process of forming a black or magnetic oxide that has a limited application, but worthy of mention as containing some possibilities for the future experimenter, is the Maritens Patent Process, in which the article to be oxidized is connected to the anode pole of a galvanic battery and immersed in hot water, when it becomes oxidized. A repetition of the process is necessary to secure a favorable result. Full information and detail of the process is given in a publication by Dr. George Langbein, of Leipzig, Germany, of which there is a translation with additions, by William T. Bramet, editor of the *Techno-Chemical Receipt Book*, 81 Liberty street, New York. In this process the water is decomposed by electrosis, the hydrogen being set free, while the oxygen goes to the iron to form an oxide coating. This process appears to be the progenitor of the electric welding process that attracted so much attention at the Columbian Exposition. In the latter case the strong current from the dynamo causes so rapid a decomposition of the water as to surround the immersed article with an envelope of hydrogen of so high tension that it prevents the escape of the heat generated by the decomposition of the water, and a rapid rise in temperature to the welding point results, the oxygen being set free, no oxide forms. The weaker current used in the Maritens process simply reversed the welding method.

THE GESNER RUST PROOF PROCESS.

This process for the preservation of iron and steel is of comparatively recent introduction, and like the Bower Barff process, forms a coating from the metal itself that it is depended upon to protect.*

While the Bower Barff process forms a magnetic oxide coating, the Gesner process claims to change the surface of the metal into a compound of hydrogen, iron and carbon, which is designated as a double carbide of hydrogen and iron; analysis of treated articles showing the presence of hydrogen in quantities from $\frac{3}{10}$ of 1 per cent. and upwards. This coating does not scale off by mechanical injury; articles treated can be bent cold to an angle of 45 degrees without injury, does not alter the dimensions of the articles treated, screw threads and nuts running together as freely after treatment as before; while the Bower-Barff process when carried to the point of forming a heavy coating of magnetic oxide, materially increases the size of the parts, and has to be allowed for in fitting up of finished and jointed parts, such as hinges and loose joints.

A claim made for articles treated by the Gesner process that they are unaffected in strength appears to have some foundation.

* United States patents to George W. Gesner, No. 376,874, January 24, 1888. Apparatus for oxidizing the surfaces of metals; described in the "Official Gazette," Vol. XLII., page 343. No. 379,866, March 20, 1888. Treatment of metals; described in the "Official Gazette," Vol. XLII, page 1,268.

See *Iron Age*, April 3, 1890, for an illustrated article of the process and apparatus; also the *Engineering Journal* (Forney's), April, 1891, for description of the process.

The record of a number of tests made at Philadelphia on an Olsen testing machine show that the wrought iron samples were comparatively unaffected in strength by the treatment, while the steel articles showed a loss in strength of about 5 per cent., and a gain of 5 per cent. in elongation, evidently from the annealing action of the muffle. Cast iron pipe treated, shows that the pores of the iron are filled, and the strength materially increased. Cases reported show an increase in bursting pressures of over 100 per cent.

The color of the treated articles is a fine deep blue black. Tempered articles, such as springs, bayonets, edge tools, etc., cannot be treated, but in some cases articles can be hardened and tempered after treatment. The process does not necessitate the use of skilled labor; after being established, ordinary working men are all that is requisite. The process is adaptable wherever tinning or galvanizing are employed to withstand atmospheric effects, and is materially cheaper than those methods. Among the adaptations for this process can be named office railings, grilles, gates, wrought, cast and malleable iron pipes and fittings, steel and iron shingles, corrugated sheets for roofing, polished wrought-iron pipe for bedsteads, steam radiators, builders' and art hardware, architectural iron work of all kinds, gun fittings, etc. These articles can be treated in small lots for prices from four and a half to seven cents per pound, and large pieces, wrought-iron pipe in 20 feet lengths in quantities will not cost over one cent per pound, including manufacturer's profit. One of the principal articles thus far treated, is a clock tower on a storage warehouse on Schermerhorn street, Brooklyn, the clock dials of which are of wrought iron scroll work, 16 feet in diameter. The surface of the treated articles appears to facilitate the spreading and adhesion of paint, if any is subsequently required on the structure.

The articles must be cleaned from scale to secure a good result, though the removal of oil and grease due to machining processes is not necessary.

The apparatus and process of treatment is, viz.:

Two ordinary clay gas retorts of any required length from 7 to 20 feet or more, are set side by side with a furnace and grate below and between them, same as a gas retort setting. Suitable doors are fitted to one or both ends of the retorts as used for gas retort work. These retorts are heated to 1,000° or 1,200° Fahr, as may be determined by the character of the articles to be treated. The articles are placed in the retorts, and exposed to the heat for 20 minutes or until they attain approximately the heat of the retort or muffle, when steam at low pressure is admitted to the inside of the retort through an iron pipe lying on the bottom of the retort, and called a hydrogen generator, which decomposes the steam, hydrogen being set free, which fills the retorts, the surplus pressure passing out by a purge pipe sealed in about 1½ inches of water to prevent ingress of air to the retorts.

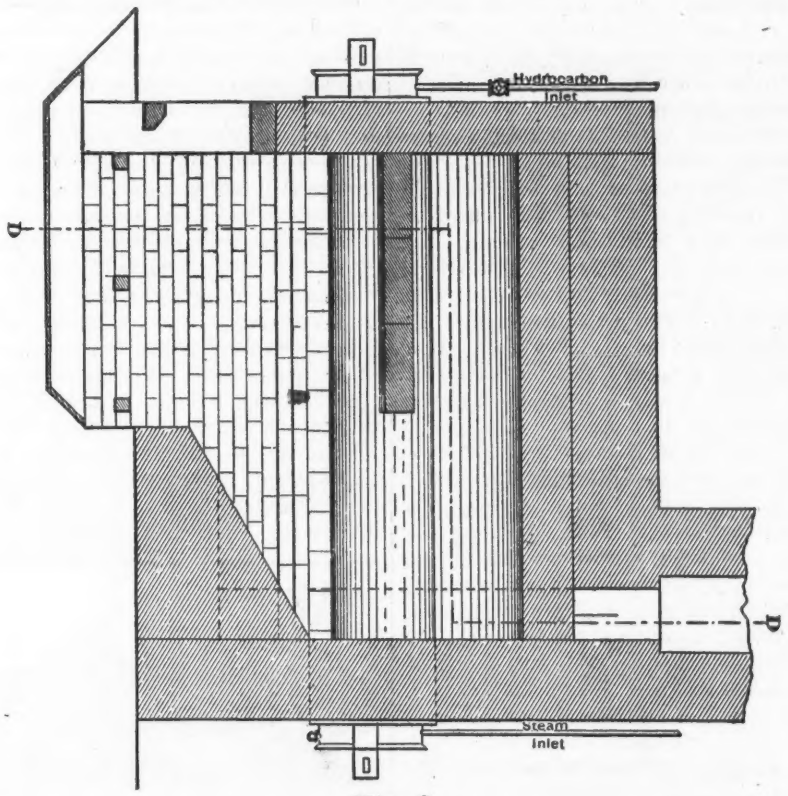


Fig. 2.

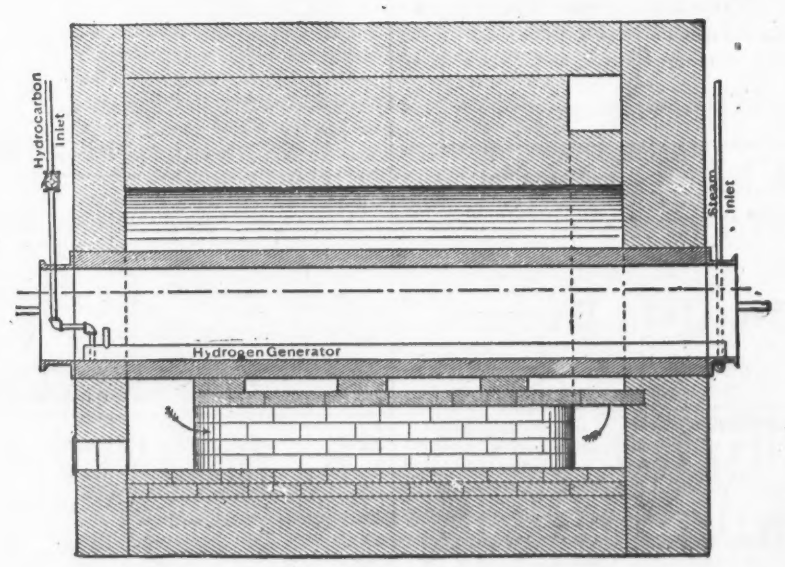


Fig. 3.

This steam treatment is kept up for 35 minutes, when a large quantity of naphtha—a pint or more—is injected by gravity into each retort, and allowed to flow for 10 minutes. The hydrocarbon is then cut off, and the steam, which has been allowed to flow during the whole operation, is continued some 15 minutes longer.

The whole time employed is therefore an hour and 20 minutes for articles of ordinary size and weight, such as builders' hardware, etc.

The articles remain in the muffle sealed from the air until the heat has fallen to about 800° Fahr., when they can be removed without danger of scaling.

Ornamental objects, art hardware, etc., while hot are given a bath in whale or paraffine oil, to render them even in tone, prevent finger marks, etc. The process appears to be almost identical with the Bower-Barff, with the exception of the use of the naphtha, which gives a foundation to the claim for the formation of a carbide that hastens the process; the time of treatment being materially lessened in the Gesner process than by the Bower-Barff to get the same thickness of coating. A number of plants for the working of this process are in operation in various parts of the United States, the principal one, The South Brooklyn Rust-Proof Iron and Steel Works, 176 Sullivan street, near Atlantic Basin, South Brooklyn, has a capacity of two tons daily output, of small articles like builders' hardware, and six tons of pipe up to 7½ feet in length and can treat articles up to 20 feet in length. Members of the American Society of Mechanical Engineers are welcome at any time to inspect the works and product, Mr. Geo. W. Gesner, proprietor, being in charge of the plant. A number of samples of rough surface and polished work are submitted for inspection.

The *London Engineer*, dated February 9, 1894, has a most excellent article upon the "Rusting of Iron and Steel;" though it recommends no remedy or process, it is so valuable a contribution to the literature upon the subject that I quote it entire:

"The phenomena of chemical combination appears to be exceedingly complex. Not so many years ago we were taught that a mixture of oxygen and hydrogen would combine to form water when an electric spark was passed through them. The matter appeared simple, was easily expressed in chemical formulæ, and illustrated by experiment. Now, we have learned that it is impossible to make such a mixture explode when it consists of perfectly pure and dry gases. When, however, the slightest trace of moisture is present the combination takes place at once, thus illustrating the importance of those 'next to nothings,' which were so ably discussed by Sir Frederick Bramwell in his address to the British Association. The oxidation of iron, though a more familiar phenomenon, is at least as complex as that of hydrogen. In spite of the proverb this familiarity has been far from breeding contempt, as its commercial importance has attracted considerable attention to the subject, and though there is much to be learned, some few facts appear to be now established. In the first place, neither bright iron nor steel will rust in pure water or in pure air. The presence of carbonic acid or some similar agent seems necessary, although the final product may be destitute of carbon. Even when oxygen, moisture, and carbonic acid are all present rusting will not take place unless the moisture condenses on the surface of the metal.

"When rusting does take place under ordinary circumstances, the first stage appears to be the formation of ferrous carbonate.

"The carbonate is then dissolved in carbonic acid water to form ferrous bicarbonate, which latter is then decomposed in presence of air and moisture to form hydrated ferric oxide, magnetic oxide being formed as an intermediate product.

"This fact, as to the formation of the magnetic oxide, is curious, as the Bower-Barff process of protecting iron and steel consists in coating the metal with a firmly adherent layer of this very oxide.

"Every one knows that when a bar of iron has commenced to rust, the corrosion proceeds apace. A polished bar will resist oxidation for a comparatively long time, even under somewhat unfavorable conditions, but once the rust has commenced to form it does not take long for it to cover the whole bar.

"One reason for this may be the fact that the rust is electro-positive to the iron, but

it is also partly attributed to the final product, the hydrated ferric oxide, being only formed at the end of several intermediate stages of the oxidation, and to its hygroscopic properties, which favor the absorption of moisture from the air. In certain situations other acids besides carbonic may take part in the corrosion of iron. The metal work in bridges over railways is particularly exposed to fumes, and some engineers consider that in such cases no plates less than ⅜ inch in thickness should be made use of, even in the case of the flooring.

"The whole question of the rusting of iron and steel work has been discussed in considerable detail by Mr. Thomas Turner, Assoc., R. S. M., F. I. C., in a paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers.

"It is now pretty generally acknowledged that, so far as ordinary exposure to the weather is concerned, iron is less liable to rust than steel. Unfortunately, however, this capacity for resisting rust seems to be greater in the common irons than in the best qualities, and has been attributed to the phosphorus contained in the former, which seems to have a protective action.

"When iron and steel are used in conjunction there is no certainty which will be the more liable to rust. The potential difference of contact between the two is very small, and though in general wrought iron is found to be electro-positive to steel, there seem reasons for believing that this may not be so in all conditions.

"Mr. W. Denny has instanced a case where the steel shell plates of a vessel remained clean, while the iron stem plate and rudder forgings were much corroded.

"The ballast tanks of ships are particularly exposed to rust. Bilge water is an exceptionally powerful corroding agent, and several engineers have suggested the use of iron plating in ships, in those parts exposed to bilge water, even when the body of the ship is of steel. In steam boilers it is claimed that there is little difference in the behavior of the two metals, and certainly steel boilers, when properly looked after, have proved to have a long life.

"Plates thoroughly cleaned from scales are less liable to corrosion than when used just as they come from the rolls; and the Admiralty have accordingly adopted the practice of pickling the plates before being used. In case of pitting, Mr. John found a particle of black oxide at the bottom of each pit.

"Experiment shows that this black oxide is strongly electro positive to the plates.

"Cast-iron seems in general to last better in sea water than either wrought iron or steel. Trautwine, however, relates that the cast-iron cannons of the 'Royal George' and the 'Royal Edgar,' after an immersion of 62 and 133 years, respectively, had become quite soft, and were in some cases like plumbago. A very similar experience was noted with the cast-iron sluice gates of the Caledonian Canal. Much apparently depends upon the quality of the iron.

"Trautwine recommends white, close-grained cast-iron, while Mr. Turner quotes from a British association report recommending gray iron.

"The alloys of iron with nickel, cobalt, and chromium appear less liable to rust than ordinary iron, while the presence of manganese appears to render the iron more sensitive to attack by corrosion."

Commenting upon the above in its reference to steam boilers, I think the presence of the scale found in most boilers acts as a partial preservative, as in general the shells of all types of boilers show the effects of corrosion more upon their external than internal surfaces. Boilers using perfectly pure or distilled water are more liable to pitting than a general corrosion over the whole surface of the shell and tubes. Why this is so is a mooted question. Pure hot water is a strong solvent of nearly all bodies; steel and iron do not escape its action, as the collapse of the Boston (Mass.) hot water circulating system forcibly shows, and is fresh in the minds of all engineers. The Heine boilers that furnished the hot water, under a pressure of 450 pounds, for the system in question, were comparatively unaffected, and other boilers and pipes under similar conditions have worked for years without showing the tendency to melt away as did the street pipes in this case.

The course of the Admiralty in causing all boiler plates to be pickled and cleaned from the scale of manufacture, is in the right direction, and should be extended to all the plates used in the construction of ships. In fact, all iron and steel requiring protection from corrosion other than by the magnetic oxide processes, and that depend upon paint for their protection, it is an indispensable condition that the scale must be removed in order to secure the best result. When this is done, and strictly pure red lead is mixed with pure raw linseed oil that has escaped the manipulations of the whale, or Menhaden oil merchant, a paint is produced that will unite so closely to the iron or steel surface as to be only secondary in preservative qualities to magnetic oxide in resisting atmospheric effects. The writer cites from his experience a number of wrought iron tie bars that in an outdoor exposure of over fifty years were as unaffected from rust as though they had been up only a week. Examination showed that the bars had been scaled before painting, and had received two coats of pure red lead and oil paint at the date of their erection, and from their location in the structure could not have been repainted without removal from their position.

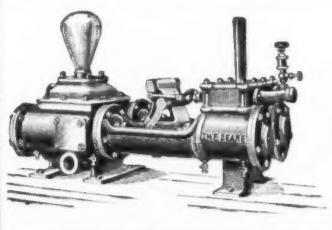
How rapidly rust will form beneath the scale of manufactured iron, one need but to look at the trusses and iron work of the elevated railways of New York to recognize the importance of this preliminary step in the protection of the surface. In this case successive coats of a poor, cheap paint are spread at intervals over the whole easily accessible parts of the structure, no efforts being made either by the engineers or painters to remove the blisters caused by the corrosion in progress beneath the first coat. How long this process can continue without seriously weakening the structure is a matter of guess-work. A suggestive lesson upon this point is found in the collapse of an iron and slate roof, covering the retort room of one of the New York gas works, that suddenly gave way without warning, and played the part of an extinguisher to all beneath. The tie rods of the trusses proportioned to withstand five times the weight of roof, with the usual allowances for wind and snow pressures, had wasted away beneath successive coats of paint and coal tar applied, until rupture came as a matter of course even under conditions of a minimum strain. The material in the old Hammersmith bridge across the Thames at London was bought by Sir William Arrol to use for false work at the Forth bridge. The iron after sixty two years of service was as good as new. Many of the parts were inaccessible, and had not been repainted since their erection. Pure white lead paint was at the bottom of the secret.

(To be Continued.)

Death of Wallace H. Dodge.

On Monday, the 10th inst., at his home in Mishawaka, Ind., Wallace Harlow Dodge, a well known inventor and prominent manufacturer, died as a result of an illness which had continued with brief intermissions since his return from Europe in 1889, where he went with the American Society of Mechanical Engineers, he being an associate member of that society. At the time of his death Mr. Dodge was 45 years of age. He was born in the town where he died, finished his education at Notre Dame University, and did very much in developing his native town as well as in building up a business of very great magnitude, especially in the manufacture of wooden pulleys.

The accidental omission of a cipher in our description of the Frenzel vacuum pan (issue of September 6th) makes its capacity appear to be one tenth of what it actually is. It will handle a charge of 15,000 pounds.



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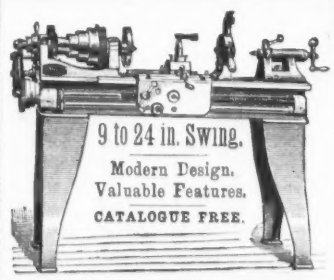

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MANUFACTURES.

Wm. F. Nevigold, who recently leased the Rome (Ga.) rolling-mill from Harper Hamilton, is now overhauling the plant, and preparing to put it in operation.

The Pettee Machine Works, of Newton Upper Falls, Mass., first American builders of revolving flat cards, are again to increase their plant by the building of a new brick shop, three stories high and 325 feet long. This company has had wonderful success with its machines.

The Toledo Bicycle Works, of Toledo, O., have recently reorganized and are now making some extensive alterations and additions to their plant. They have just closed a contract with the Lodge & Davis Machine Tool Co., of Cincinnati, O., for an outfit of machinery suitable for the manufacture of bicycles.

At a recent meeting of the directors of the Walter A. Wood Company, of Hoosick Falls, N. Y., it was voted to immediately make repairs at the malleable works and, when completed, resume work with a force of about 300 men. Work will be resumed in the main works as soon as the necessary material shall be prepared at the malleable works.

The Frank-Kneeland Machine Co., of Pittsburgh, has been awarded the contract for a 34-inch blooming mill, manipulator and ingot tilter, also a 26 inch double 3-high plate mill with lifting tubes, for the St. Louis Stamping Co. The plant was designed by Messrs. McClure & Amsler, of this city. The Frank-Kneeland Co. in the past four weeks has received orders for quite a quantity of work and present orders for tin-mill, sheet-mill and bar-mill rolls are reported as quite satisfactory.

The Lane & Bodley Co., Cincinnati, O., are receiving bids for limestone foundations, brick, carpenter and mill work, roofing and structural steel work for a new addition to their machine shop, 40 feet by 147 feet, six stories in height, and also for building materials separately therefor, and have specifications prepared for electric power generating and distributing plant, including motors, wiring, arc and incandescent lamps and several direct motor driven machine tools. Specifications may be had upon application.

Recently we noted the fact that F. E. Reed & Co., of Worcester, Mass., had brought out a new wood-turning lathe. We neglected to state that this lathe was especially designed for manual training schools, and that there would be sent a catalogue to that effect. The trouble was that the lathe appeared to us a real good one for any purpose for which such a tool might be used, and it didn't seem necessary to say that it was real good for a training school. We think any fellow who had contrived to get a little experience could do a good job on this lathe.

The Tradesman, Chattanooga, Tenn., in its report on the industrial condition of the South for the week ending September 17th says: More activity exists at present in the cotton-mill industry than has been noted for a considerable time. A mill to cost $250,000 is to be built at Gaffney, S. C., one to cost $300,000 is in contemplation at Savannah, Ga. Enlargements of existing mills will be made at Dalton and Columbus, Ga., one to cost $60,000 is reported at Shreveport, La., and the citizens of Gadsden, Ala., intend to raise $600,000 wherewith to build and equip a mill on a large scale. The rolling-mills in the West Virginia district have large contracts on hand, and the extensive improvements lately made at Birmingham, Ala., are to be utilized at once in the manufacture of structural iron. Southern lumbermen report better business and more favorable prospects.

The following will explain itself: The first of September marked the retirement of Mr. S. S. Townsend from the general Eastern agency of the Roots' blower, with which he has been identified for the past 26 years. In that period the output has grown from about a dozen machines to several hundred per annum, and this expansion has been due very largely to Mr. Townsend's energy and push. He had the Roots Co. make the first blacksmith blower, the first portable forge, and the first gas exhauster ever turned out of their works. The first adaptation of the Roots' blower for pneumatic tube work was made by Mr. Townsend in the Western Union Telegraph Co.'s former New York City headquarters. Among the notable plants supplied by Mr. Townsend in the early days were blowers for operating the Beach Pneumatic Tunnel under Broadway at Warren street (the tunnel excavation still remains), and a blower for ventilating the famous Sutro Tunnel in California. From these beginnings the Roots' machines have been adopted for similar purposes all over the world. Messrs. Cooke & Co., of No. 165 Washington street, who have long been associated with Mr. Townsend, will continue to act as selling agents, and their long familiarity with the business in all its details guarantees the same prompt and intelligent attention to which the public has been accustomed under Mr. Townsend's management.

Machinists' Supplies and Iron.

NEW YORK, September 22, 1894.

Iron—American Pig—We quote standard brands, $12.50 to $13 for No. 1; $11 to $12 for No. 2. Southern brands, $11.50 to $12 for No. 1; $11 to $11.25 for No. 2; $10.35 to $10.50 for No. 3; $11 to $11.25 for No. 1 soft; $10.75 to $11 for No. 2 soft. Foundry No. 4, $9.75 to $10.25.

Antimony—We quote L. X., 8.30c. to 8.82½c.; Cookson's, 9½c. to 9¾c.; Hallett's, 7.40c. to 7½c.; and U. S. French Star, 9¼c. to 9½c.

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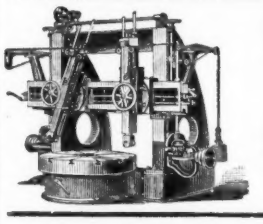

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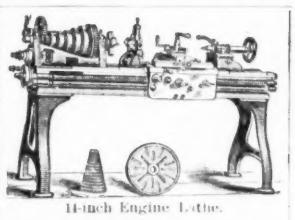

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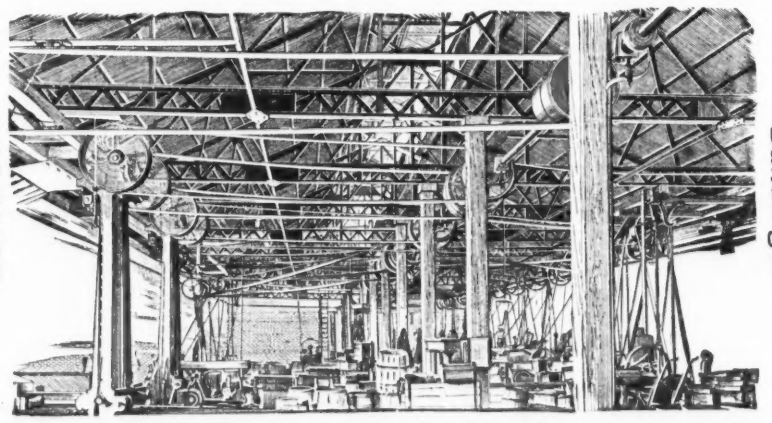

Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Upson Nut Co., at Unionville, Conn., over their Forge Shop. The building is 45 feet in width by 184 feet in length, with brick walls and iron roof trusses covered with corrugated iron. No wood-work is used about the construction in any way, shape or manner, so that the danger from fire is entirely eliminated. Extending the full length of the building, on the ridge, is a ventilator with swing shutters which open and close by cords from the floor.

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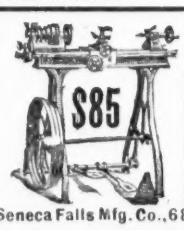

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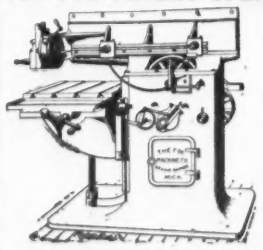

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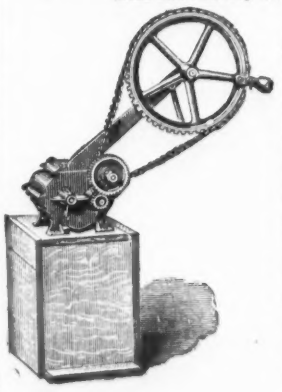

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"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Sit. wanted by a steady machinist, 32 years old, 15 years' exp. Machinist, AMERICAN MACHINIST.

Draftsman, grad., 6 years' exp. in eng. and boiler work, wants position. Box 7, AM. MACHINIST.

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Mech. draftsman, young man, wants pos. Good photographer. Salary low. J. W. F., AM. MACH.

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Mechanical engineer seeks sit. constructing or running; special machinery, etc. P. R., AM. MACH.

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Mech. eng., with 12 years' practical experience in designing of steam and general mach'y, member of A. S. M. E., is open for pos. Box 9, AM. MACH.

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Responsible pos. by reliable mech. expert; compet't take charge of men, reduce cost of production; A1 tool maker & designer. Box 23, AM. MACHINIST.

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Wanted—A thoroughly experienced engine man who understands the construction & operation of engines & gen. mach'y for outside work: erect'g engines & steam plants. Buffalo Forge Co., Buffalo, N.Y.

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Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

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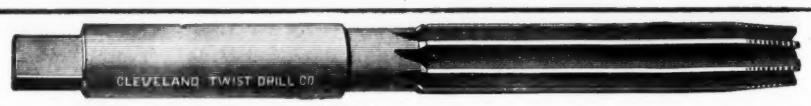

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3 Spindle Slate Sensitive.
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Radial Drill, 86 in. complete.

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Lincoln Pattern, very cheap.
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Bement Cyl. Borer, 12 to 36 in.
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20 " x 12 " Prentiss Taper.
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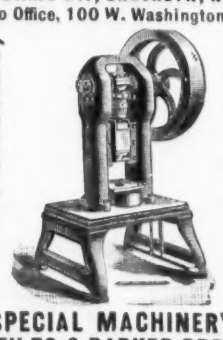

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5 ft. Arm Radial Drill.
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16 in. x 4 ft. Planer.
24 " 4, 5 and 6 ft. Planer.
28 " 5 and 8 " "
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60 " 20 " "
72 " 25 " "
9, 12, 16 24 and 26 in. Stroke Shaper.
10 in. Stroke Slotter.
Hyd. Rivetting Machine.
" Crane, Both Al.
Punch and Shear.
Plate Planer.
11 in. x 5 ft. Eng. Lathe.
14 " 6 " " "
15 " 6 and 8 ft. Eng. Lathe.
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35 " 13 " " "
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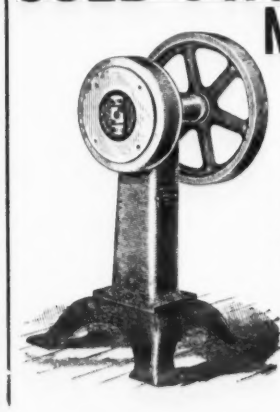

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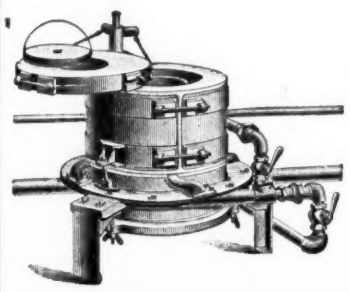

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15 " x 6 " Blaisdell.
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16 " x 7 " Bement.
16 " x 8 " Perkins, Taper.
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3 each 12 in. and 15 in. Lever and Screw Movement to Turret.
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52 in. Comb. Radial.
80 in. Comb. Radial.
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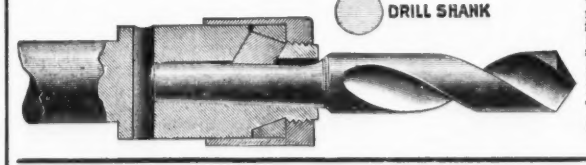

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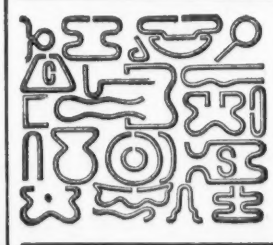

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OF EVERY DESCRIPTION.

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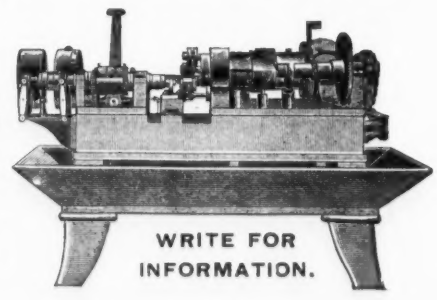

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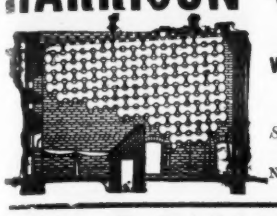

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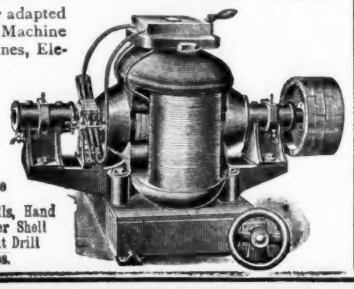

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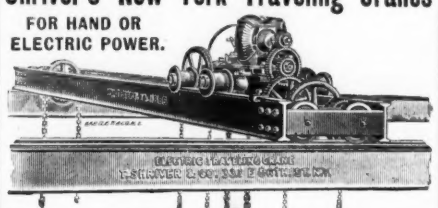

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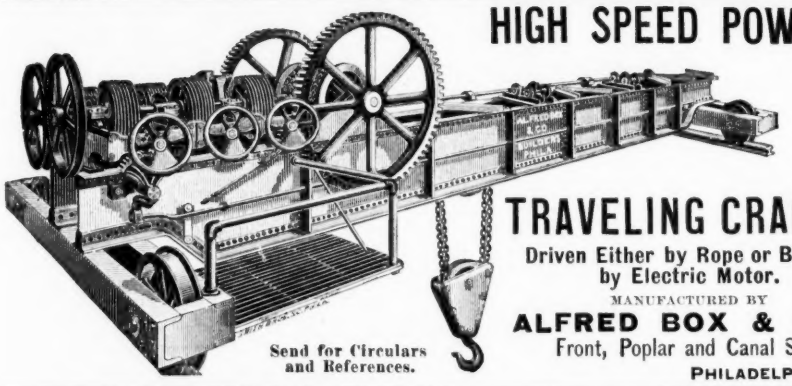

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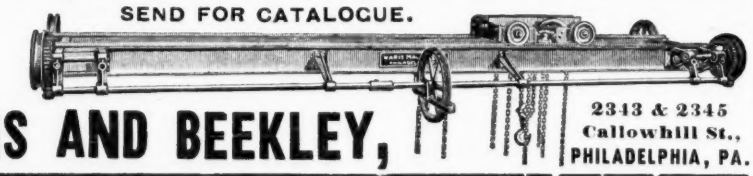

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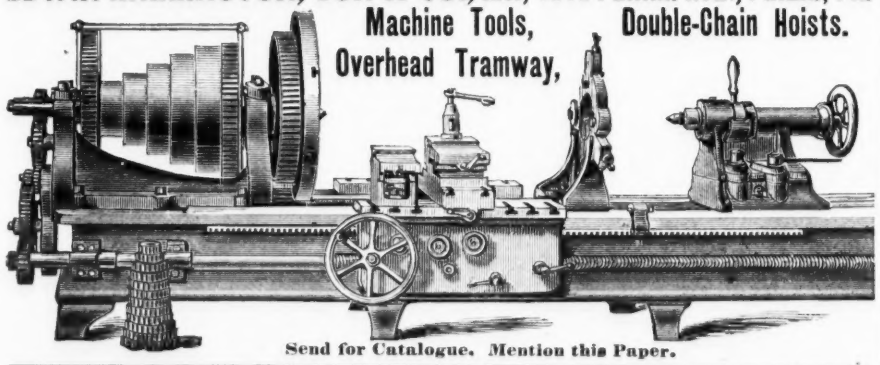

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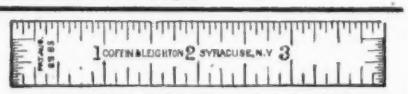

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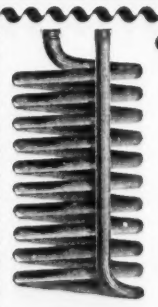

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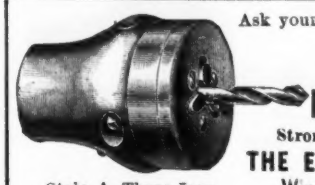

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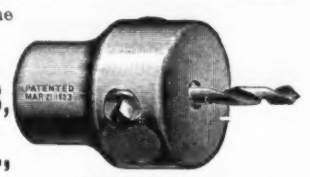

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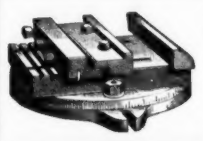

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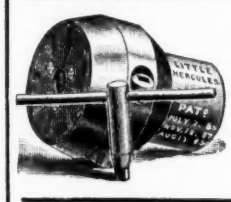

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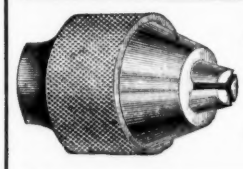

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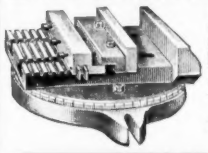

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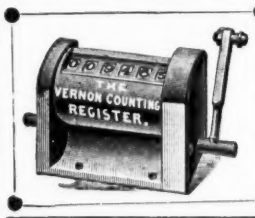

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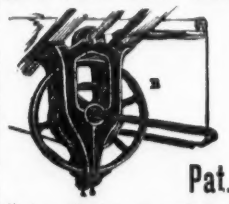

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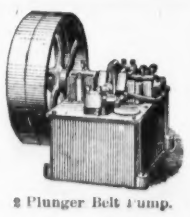
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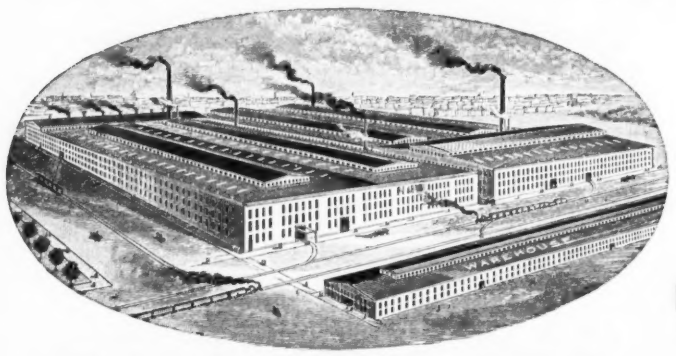

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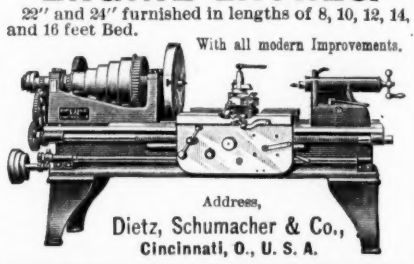

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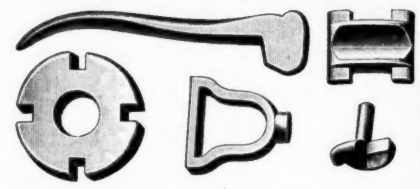

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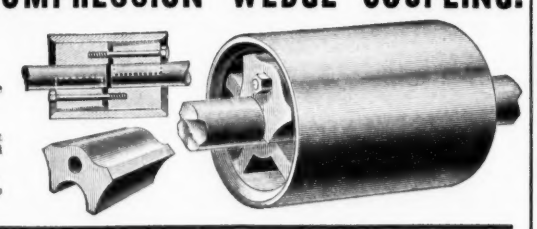

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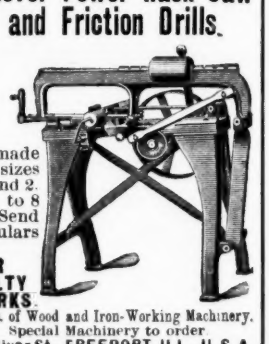

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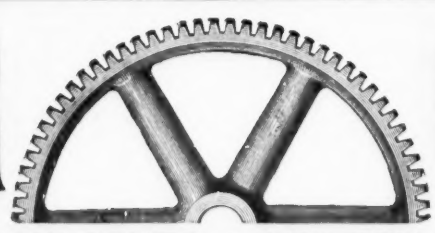

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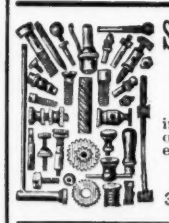

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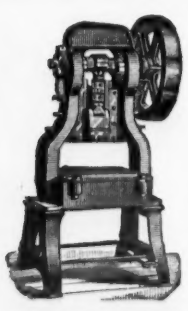

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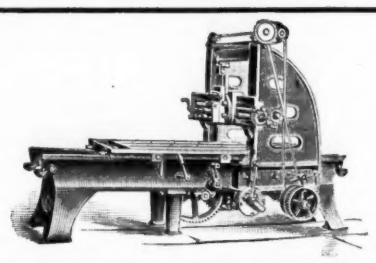

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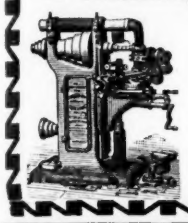

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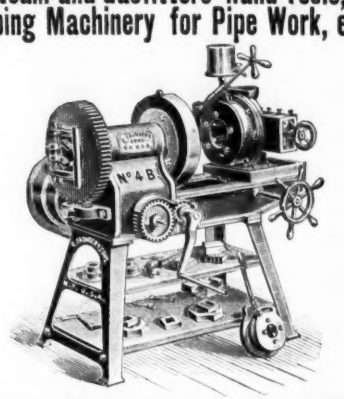

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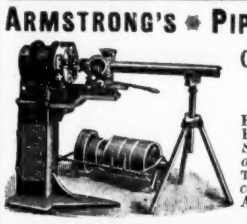

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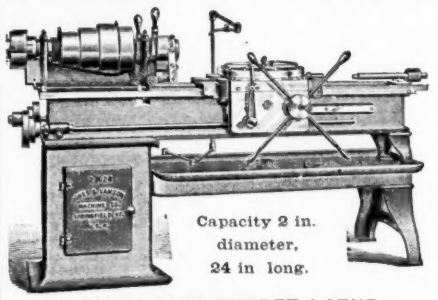

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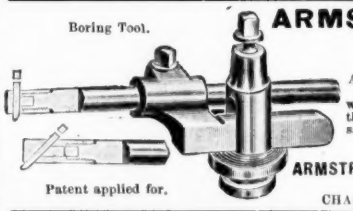

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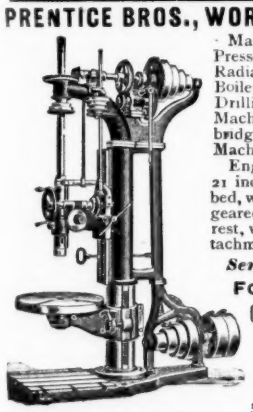

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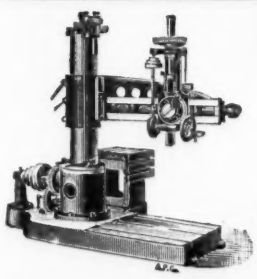

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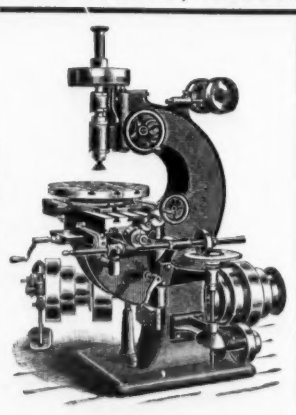

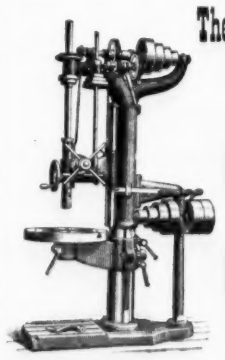

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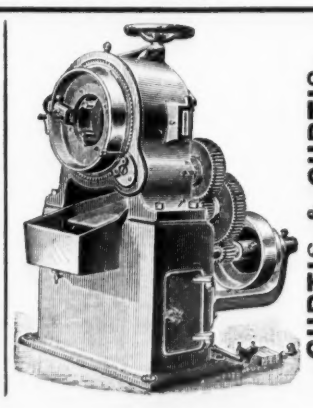

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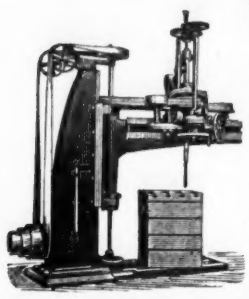

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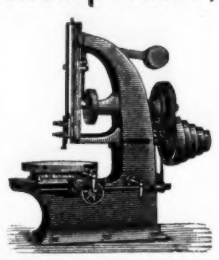

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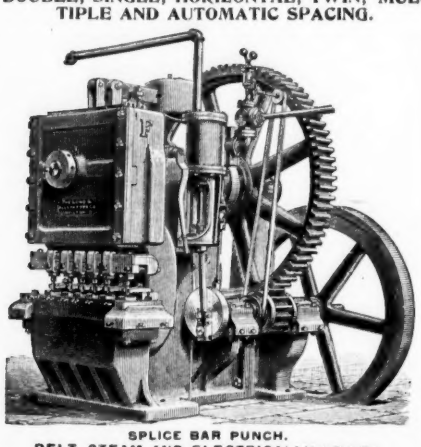

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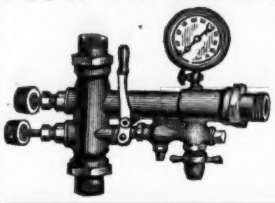

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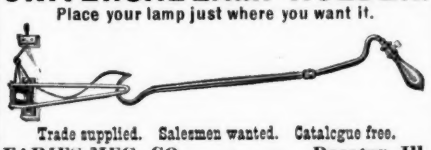

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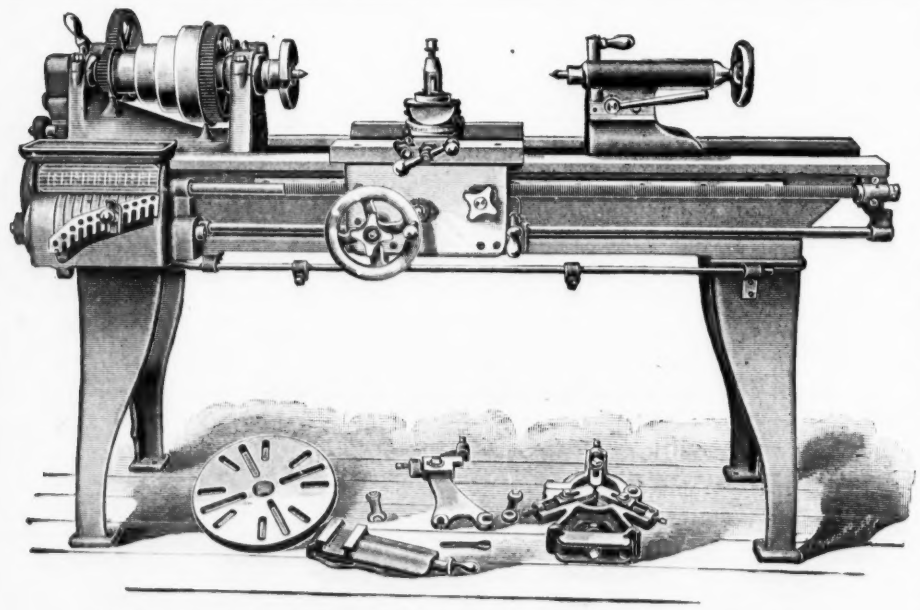

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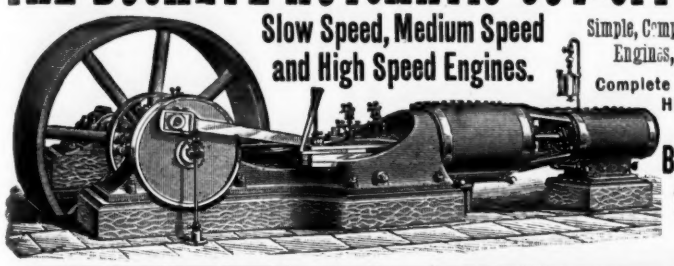

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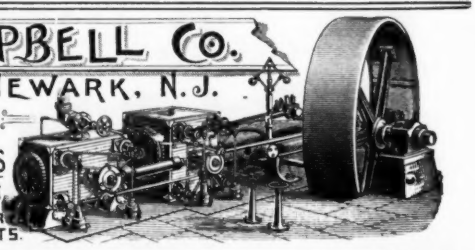

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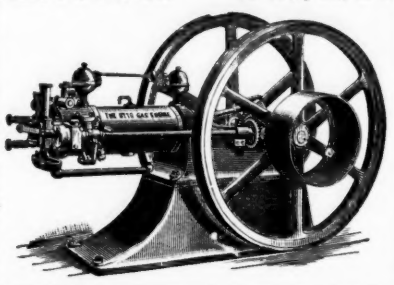

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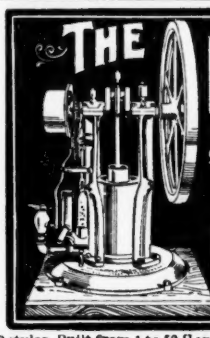

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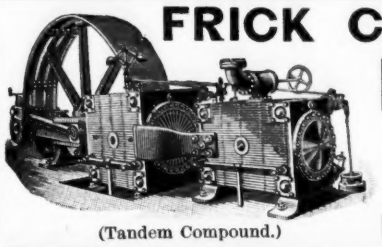

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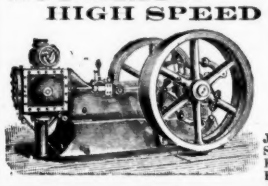

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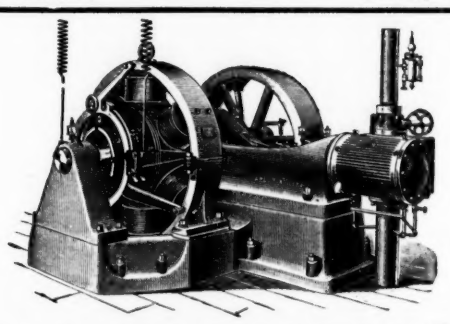

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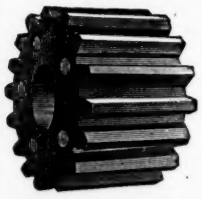

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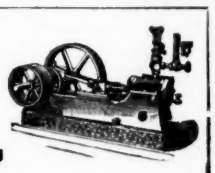

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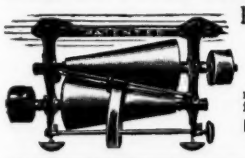

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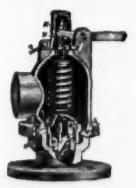

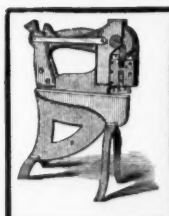

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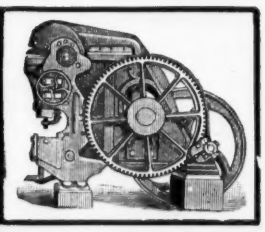

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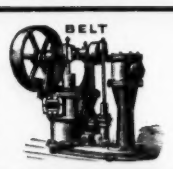

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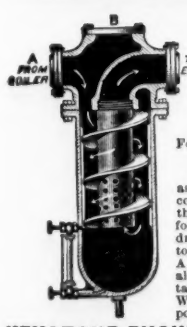

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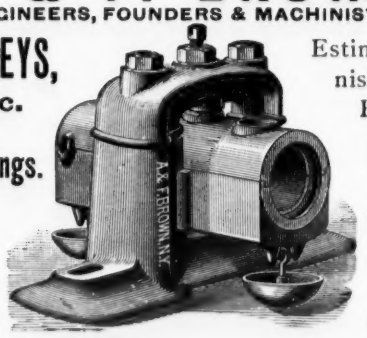

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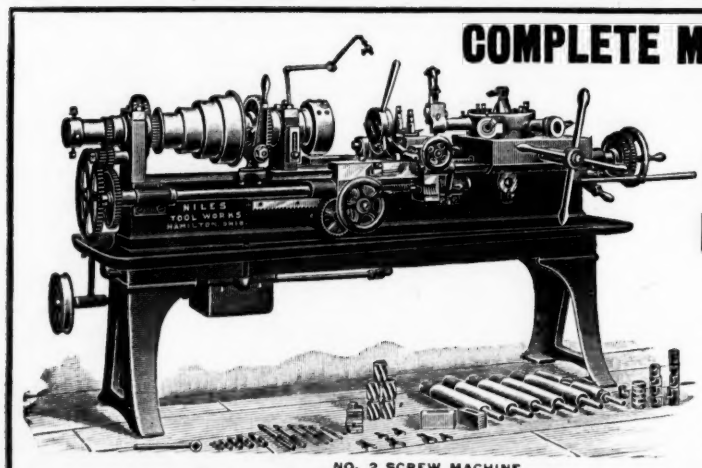

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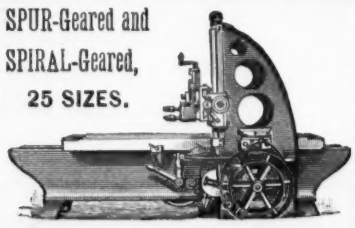

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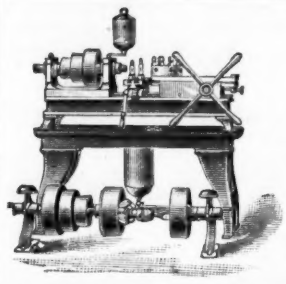

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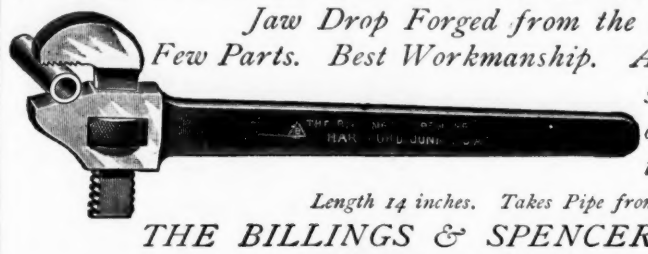

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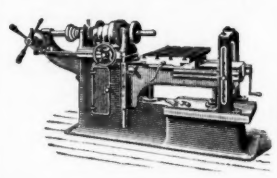

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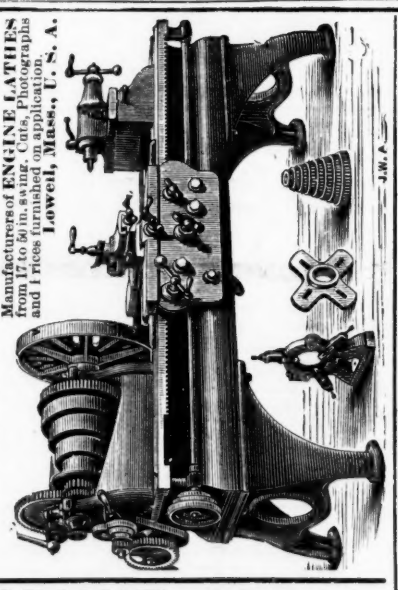

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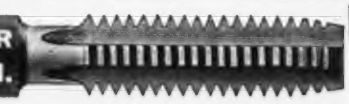

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